Department of Environmental Protection

2600 Blair Stone Road ♦ Tallahassee, Florida 32399-2400

DEP Form: 62-762.901(9)
Form Title: Storage Tank Equipment Registration Form
Effective Date: July 2019
Incorporated in Rule 62-762.851, F.A.C.

Storage Tank System Equipment Registration Form

Fill out completely

General Information

Company Name: Honeywell Enraf Inc
Contact Name: Daniel Vila
Company Address: 11201 Greens Crossing Blvd, Suite 400
City, State: Houston, TX
Zip: 77067
E-mail: daniel.vila@honeywell.com
Contact Number: (832) 606-4654
Product Name: Smart Servo
Model Number(s): 954
Product Type: Servo Level Gauge
Rule(s) citation that registration is being requested within Chapter 62-761 (UST), and/or 62-762 (AST), F.A.C.:
62-762 (AST)

Write a brief description of equipment registration request including product limitations:

Request for the Honeywell Enraf 954 SmartServo. New generation of our Servo Level gauge to measure LEVEL, WATER INTERFACE and Density on bulk tanks, specially focused on Oil and Gas industry but not excempt to be used in other markets. Not recommended to be used in Heavy crudes or viscous products. This replaces the old 854ATG previously registered with DEP, which has been declared obsolete, previously registered in DEP under EQ-379

Information Checklist (Choose Yes, No, or N/A - Not Applicable):

		Yes	No	N/A
1.	Third-party Certification by a Nationally Recognized Testing Laboratory? (Required)	✔		
2.	Documentation of third-party evaluation that the equipment meets DEP Rules?		✔	
3.	Documents included about the qualifications of the Nationally Recognized Testing Laboratory?	✔		
4.	Technical information and drawings included?	✔		
5.	Installation instructions included?	✔		
6.	Annual Operability Testing Requirements (Rules 62-761.500, 62-762.501, & 62-762.502 F.A.C.)?			✔
7.	Integrity Testing Requirements (Rules 62-761.700, 62-762.701, & 62-762.702, F.A.C.)?			✔
8.	Compatible with fuel blends containing >10% ethanol or >20% biodiesel?	✔		
9.	Has the product been approved or registered in other countries or states? (If so provide list)	✔		
10.	Any requirements for company-certified installers or trainers?			✔
11.	Was this product(s) previously approved or registered by the Department? If yes, EQ- **379**	✔		
12.	Any changes or modifications to the equipment since the last submittal to DEP?		✔	

Document Information: Provide supporting documents indicated as "Yes" above including this form via email to Tanknotify@floridadep.gov, or documents can be sent to FDEP, Division of Waste Management, 2600 Blair Stone Road, MS 4560, Tallahassee, FL 32399.

Write a brief description of equipment installation and performance in the U.S.:

Our servo level gauges have been installed and used in more than 400 Oil and Gas Distribution Terminals and refineries in the US as well as in about 75% of airports in the country and US Airforce bases around hte world. Used not only for level measurement but also for overfill protection.

Equipment Registration Certification:

To the best of my knowledge and belief, all information submitted on this form is true, accurate and complete.

Daniel Vila
Printed Name and Title

Signature (right click to sign)

11/18/2025
Date

For Department Use Only:

Date Application Received: 11/19/2025
Application complete: Yes: ✔ No:

EQ- 1043
Date of complete or incomplete letter sent: 11/20/2025
Date Equipment Requires Renewal: **11/20/2030**

Storage tank system equipment requires renewal every 5 years in accordance with subsection 62-762.851(2), F.A.C.

CERTIFICATE OF CONFORMITY

FM Approvals

1. **HAZARDOUS (CLASSIFIED) LOCATION ELECTRICAL EQUIPMENT PER US REQUIREMENTS**
2. **Certificate No:** **FM19US0012**
3. **Equipment:** **SmartServo FlexLine 954, Automatic Tank Gauge**
   (Type Reference and Name)
4. **Name of Listing Company:** **Enraf BV**
5. **Address of Listing Company:** **Delftechpark 39, 2628 XJ Delft, The Netherlands**
6. The examination and test results are recorded in confidential report number:

   PR451549 dated 1st March 2019

7. FM Approvals LLC, certifies that the equipment described has been found to comply with the following Approval standards and other documents:

   FM 3600:2022, FM 3610:2021, FM 3615:2022, FM 3810:2021, NEMA 250:1991, ANSI/UL 60079-0:2013, ANSI/UL 60079-11:2014, ANSI/UL 61010-1:2012

8. If the sign 'X' is placed after the certificate number, it indicates that the equipment is subject to specific conditions of use specified in the schedule to this certificate.
9. This certificate relates to the design, examination and testing of the products specified herein. The FM Approvals surveillance audit program has further determined that the manufacturing processes and quality control procedures in place are satisfactory to manufacture the product as examined, tested and Approved.
10. Equipment Ratings:

    Explosionproof with intrinsically safe outputs for connection to Class I, Division 1, Groups B, C and D, temperature code T6 for Ta = -40°C to +65°C hazardous (classified) locations, indoors and outdoors (Type 4X).

11. The marking of the equipment shall include:

    XP-AIS, Class I Division 1, Groups B, C, D; T6
    Ta = -40°C to +65°C;
    Type 4X
    Refer to control drawing #135-1954000-3.

Certificate issued by:

J.E. Marquedant

5 December 2024

J.E. Marquedant
VP, Manager - Electrical Systems

Date

To verify the availability of the Approved product, please refer to www.approvalguide.com

FM Approvals LLC. One Technology Way, Norwood, MA 02062 USA
T: +1 (1) 781 762 4300 F: +1 (1) 781 762 9375 E-mail: information@fmapprovals.com www.fmapprovals.com

12. **Description of Equipment:**

General - The 954 SmartServo FlexLine is an Automatic Tank Gauge measuring the surface or interface level of crude oil or derived products stored in a bulk storage tank. Typically, the storage tanks are available on terminals, production plants, and refineries in the petrochemical, oil and gas industry.

Construction – The 954 SmartServo FlexLine enclosure is made of Aluminum Casting. The product consists of an Electronic compartment and a Terminal compartment, which are both covered with screwable lids. The Drum compartment with the measuring wiredrum has a flange for connection on the tank nozzle.

Ratings - 65-240 VAC or 24-65 VDC.

SmartServo FlexLine abcdefghijklmnopq. Automatic Tank Gauge.

a	954A, 954M
b = X, Y, I, H, U or A	X: Accuracy ± 0.4 mm Xtreme Performance, Legal Metrology with OIML R85 report and sealing facilities.
	Y: Accuracy ± 0.4 mm Xtreme Performance per OIML R85, with factory calibration report according to OIML.
	I: Accuracy = ± 1mm. High Performance, for custody transfer acc. To OIML R85, API 3.1B and ISO 4266 (1 & 3) with factory calibration report according to OIML.
	H: Accuracy = ± 1mm. High Performance, for custody transfer acc. To OIML R85, API 3.1B and ISO 4266 (1 & 3).
	U: Accuracy ± 3 mm. Advanced Performance, for inventory control acc. To API 3.1B and ISO 4266 (1 & 3) with factory calibration report.
	A: Accuracy ± 3 mm. Advanced Performance, for inventory control acc. To API 3.1B and ISO 4266 (1 & 3).
c = A or B	A: With internal display.
	B: With internal display and terminals for stand-alone HART SmartView.
d = -	Protocol choice; no impact on safety.
e = -, V, C, H or D	-: None.
	V: VITO temperature and/or water sensor.
	C: VITO temperature and/or water sensor and 1 HART input.
	H: HART input (up to 3 HART devices).

e = -, V, C, H or D	D: HART input (up to 3 HART devices) and HIMS safety calculations.
f = -, A, C, D, E or F	-: None
	A: VITO temperature and/or water sensor.
	C: VITO temperature and/or water sensor and 3 HART inputs.
	D: VITO temperature and/or water sensor and 3 HART inputs and HIMS density calculations.
	E: HART input (5 HART inputs).
	F: HART input (5 HART inputs) and HIMS density calculations.
g= -, R, S, 3, 4, 5 or 6	-: None.
	R: RTD one spot element 3-wire.
	S: RTD one spot element 4-wire.
	3: RTD 3 elements MRT/MPT common return.
	4: RTD 4 elements MRT/MPT common return.
	5: RTD 5 elements MRT/MPT common return.
	6: RTD 6 elements MRT/MPT common return.
h = -, K or L	-: None.
	K: Hardware alarms (1 x SPDT) 250 VAC, 2A (40 VDC, 2A).
	L: Hardware alarms (2 x SPDT) 250 VAC, 2A (40 VDC, 2A).
i = -, L, M, N, O or P	-: None.
	L: 1 x SIL DO contact (1 x SPDT contact, 2A at 250 VAC or 2A at 40 VDC, P_{max} = 500W).
	M: 2 x SIL DO contact (2 x SPDT contact, 2A at 250 VAC or 2A at 40 VDC, P_{max} = 500W).
	N: SIL AO NAMUR NE43 compliant.
	O: SIL AO + 1 SIL DO contact NAMUR NE43 compliant (1 x SPDT contact, 2A at 250 VAC or 2A at 40 VDC, P_{max} = 500W).
	P: SIL AO + 2 SIL DO contacts NAMUR NE43 compliant (2 x SPDT contact, 2A at 250 VAC or 2A at 40 VDC, P_{max} = 500W).

FM Approvals LLC. One Technology Way, Norwood, MA 02062 USA
T: +1 (1) 781 762 4300 F: +1 (1) 781 762 9375 E-mail: information@fmapprovals.com www.fmapprovals.com

j = -	-: None, or select from option c.
k = A11, M21, C11, C12, H52 or H53	A11: Atmospheric pressure, 2” Class 150 FF, Flanges acc. ASME B16.5 (Ra = 3.2-6.3 µm), AL.
	M21: Medium pressure, 2” Class 150 FF, Flanges acc. ASME B16.5 (Ra = 3.2-6.3 µm), AL, Up to 6 Bar.
	C11: Chemical version, 2” Class 150 FF, Flanges acc. ASME B16.5 (Ra = 3.2-6.3 µm), AISI 316, Up to 6 Bar.
	C12: Chemical version, DN50, PN 6, Flanges acc. EN 1092-1 (Ra = 3.2-12.5 µm), AISI 316, Up to 6 Bar.
	H52: High pressure, 2” Class 300 RF, Flanges acc. ASME B16.5 (Ra = 3.2-6.3 µm), AISI 316, Up to 40 Bar. Air purge included.
	H53: High pressure, DN50, PN40, Flanges acc. EN 1092-1 (Ra = 3.2-12.5 µm), AISI 316, Up to 40 Bar, Air purge included.
l = F	F: FM - USA
m = -	-: Measuring length/wire material. No impact on safety.
n = -	-: Displacer material/diameter. No impact on safety.
o = -	-: Displacer for density dip. No impact on safety.
p = -	-: NACE compliance. No impact on safety.
q = -	-: Additional tag plate options. No impact on safety.

13. **Specific Conditions of Use:**

    None.

14. **Test and Assessment Procedure and Conditions:**

    This Certificate has been issued in accordance with FM Approvals US Certification Requirements.

15. **Schedule Drawings**

    A copy of the technical documentation has been kept by FM Approvals.

16. **Certificate History**

    Details of the supplements to this certificate are described below:

SCHEDULE

US Certificate of Conformity No: FM19US0012

Date	Description
1 March 2019	Original Issue.
26 January 2021	Supplement 01: Report Reference: – PR458538 dated 26th January 2021. Description of the Change: Addition of Model 954M for 854 ATG to 954 SmartServo FlexLine Migration Kit.
5 December 2024	Supplement 2: Report Reference: PR469765 dated 5 December 2024. Description of the Change(s): Addition of Group B certification.

Certificate

Product Safety
Functional
Safety

TÜVRheinland CERTIFIED

www.tuv.com
ID 0600000000

No.: 968/FSP 1489.01/19

Product tested	Level transmitter for safe detection of overfill and/or underfill	**Certificate holder**	Enraf B.V. Delftechpark 39 2628 XJ Delft The Netherlands
Type designation	954 SmartServo FlexLine		
Codes and standards	IEC 61508 Parts 1-7:2010		
Intended application	The device complies with the requirements of the relevant standards (Hardware safety integrity SIL 2 acc. to IEC 61508 and systematic capability SC 3 acc. to IEC 61508) and can be used in applications up to SIL 2 (HFT=0) resp. SIL 3 (HFT=1) acc. to IEC 61508 and IEC 61511 for the safety function overfill and/or underfill. The product was also reviewed in reference to the requirements of IEC 61511-1:2016 +Corr.1:2016+AMD1:2017 applicable during a type examination.		
Specific requirements	The instructions of the associated installation, safety and service manuals shall be considered.		

Valid until 2024-03-18

The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/FSP 1489.01/19 dated 2019-03-18.
This certificate is valid only for products which are identical with the product tested.

Köln, 2019-03-18

TÜV Rheinland Industrie Service GmbH
Bereich Automation
Funktionale Sicherheit
Am Grauen Stein, 51105 Köln
Certification Body Safety & Security for Automation & Grid

Dipl.-Ing. Gebhard Bouwer

TÜV Rheinland Industrie Service GmbH, Am Grauen Stein, 51105 Köln / Germany
Tel.: +49 221 806-1790, Fax: +49 221 806-1539, E-Mail: industrie-service@de.tuv.com

www.fs-products.com
www.tuv.com

TÜVRheinland®
Precisely Right.

Honeywell

Installation Manual
954 SmartServo FlexLine

For service related questions contact:

Head Office - Delft, The Netherlands

Honeywell Enraf
Delftechpark 39, 2628 XJ Delft
PO Box 812, 2600 AV Delft
The Netherlands

Tel.: +31 (0)15 2701 100
Fax: +31 (0)15 2701 111

E-mail: HFS-TAC-Support@Honeywell.com
Website: www.honeywellprocess.com

About this manual

This manual provides information related to installation of the 954 SmartServo FlexLine.

For servicing of the device refer to the 954 SmartServo FlexLine Service Manual listed below in References.

For Safety instructions and procedures refer to the 954 SmartServo FlexLine Safety manual listed below in References.

Introduction

The 954 SmartServo FlexLines an automatic tank gauge measuring the surface or interface level of crude oil or derived products stored in a bulk storage tank. Typically those storage tanks are available on terminals, production plants and refineries in the petro chemical, oil and gas industry. The environment on those sites is typically explosion hazardous.

The end user will typically use the 954 SmartServo FlexLine together with a Terminal Inventory System for custody transfer operations, therefore Weights and Measures legislation is applicable.

The 954 SmartServo FlexLine is based on the modular FlexConn board architecture. Every FlexConn board supported in this device is described in detail.

Revision History

954 Installation Manual (This document)

4417341	00	9th November 2018 (1st Release)
4417341	01	20th November 2018 (Updated the document)
4417341	02	22nd November 2018 (Updated the document)
4417341	03	23rd November 2018 (Finalized the document)
4417341	04	29th November 2018 (Added Relay Output Section)
4417341	05	29th November 2018 (Updated Pmax on Relay Output)
4417341	06	10th December 2018 (Updated pages 21 and 32)
4417341	07	10th January 2019 (Added FM information on page 16)
4417341	08	17th January 2019 (Added temperature range on page 16)
4417341	09	23rd January 2019 (Added I/O text to tables on page 35, 36, 38 & 39)
4417341	10	12th March 2019 (Added CSA information on page 16)

References

The following list identifies publications that may contain information relevant to the information in this document.

4417340	1	954 Service Manual
4417342	1	954 Safety Manual

Patents

The Honeywell 954 SmartServo FlexLine servo-based level gauge is covered by the following patents:

US2017307461 (A1) 2017-10-26, US2018058960 (A1) 2018-03-01

WO2017062413 (A1) 2017-04-13, WO2018044518 (A1) 2018-03-18

Contents

Figure

1. GENERAL

1.1. Using this Installation Guide

The 954 SmartServo FlexLine is used in measurement systems for inventory measurement and control. The 954 SmartServo FlexLine can integrate data from other measurement devices, such as temperature RTD sensors.

Data from 954 SmartServo FlexLine and connected sensors can be communicated to host computer systems via a variety of industry standard protocols.

1.2. Related Documents

- 954 SmartServo FlexLine Safety instructions for installation, commissioning, operation, and maintenance; shipped with the device
- CE Declaration of Conformity
- EC-Type Examination Certificate
- IEC-Ex Certificate of Conformity
- Control drawings for FM and CSA

1.3. Trademarks

HART® is a registered trademark of the HART Communication Foundation.

1.4. Contact

Head Office - Delft, The Netherlands
Honeywell Enraf
Delftechpark 39, 2628 XJ Delft
PO Box 812, 2600 AV Delft
The Netherlands

Tel.: +31 (0)15 2701 100
Fax: +31 (0)15 2701 111
E-mail: enraf.helpdesk@honeywell.com
Website: http://www.honeywell.com/ps

2. SAFETY AND SECURITY

2.1. General

The 954 SmartServo FlexLine is a servo-based level gauge which is used in inventory measurement systems. It can also be used to interface with other systems and sensors such as pressure, density, or temperature sensors.

For the correct and safe servicing of this product, it is essential that all personnel follow the generally accepted safety procedures in addition to the safety precautions specified in this manual.

2.2. Safety Conventions

2.2.1. WARNINGS

The following warning symbol is used in this manual to urge attention in order to **prevent personal injuries** or **dangerous situations**, further described in this manual.

Symbol	Description	Remark
	*General warning*	*Will always be explained by text.*

2.2.2. CAUTIONS

The following caution mark is used in this manual to urge attention in order ***to prevent damages to the equipment*** further described in this manual.

Symbol	Description	Remark
	*General caution sign*	

2.3. Safety Instructions

2.3.1. Safety Instructions

See the safety instructions shipped with the device for installation, commissioning, operation, and maintenance.

2.3.2. EC Declaration of Conformity (for EU)

Refer to the EC declaration of conformity shipped with the device.

2.3.3. Control Drawings for FM & CSA

Refer to the control drawings shipped with the device.

2.3.4. Users

The mechanical and electrical installation must be carried out only by trained personnel with knowledge of the requirements for installation of explosion-proof equipment in hazardous areas.

The entire installation procedure must be carried out in accordance with national, local, and company regulations.

The entire electrical installation shall be carried out in accordance with the national requirements for electrical equipment to be installed in hazardous areas.

NOTE:
See EN IEC 60079-14 or NEC (NFPA70).

2.3.5. Additional Information

If you require additional information, contact Honeywell or its representative.

2.3.6. Environmental Conditions

Observe the environmental conditions for the temperature and the pressure.

Ambient Operating Temperature Range from -40°C (-40°F) up to +65°C (149°F).

2.4. **Liability**

The information in this Installation Manual is the copyright property of Honeywell. Honeywell disclaims any responsibility for personal injury or damage to equipment caused by:

- Deviation from any of the prescribed procedures,
- Execution of activities that are not prescribed,
- Neglect of the safety regulations for handling tools and use of electricity.

The contents, descriptions and specifications in this Installation Manual are subject to change without notice. Honeywell accepts no responsibility for any errors that may appear in this Installation Manual.

WARNING!
Only certified technicians are authorized to make changes on the 954 SmartServo FlexLine configuration. All modifications must be in accordance to the guidelines as set forth by Honeywell. Modifications not authorized by Honeywell will invalidate the approval certificates.

2.5. **Labels**

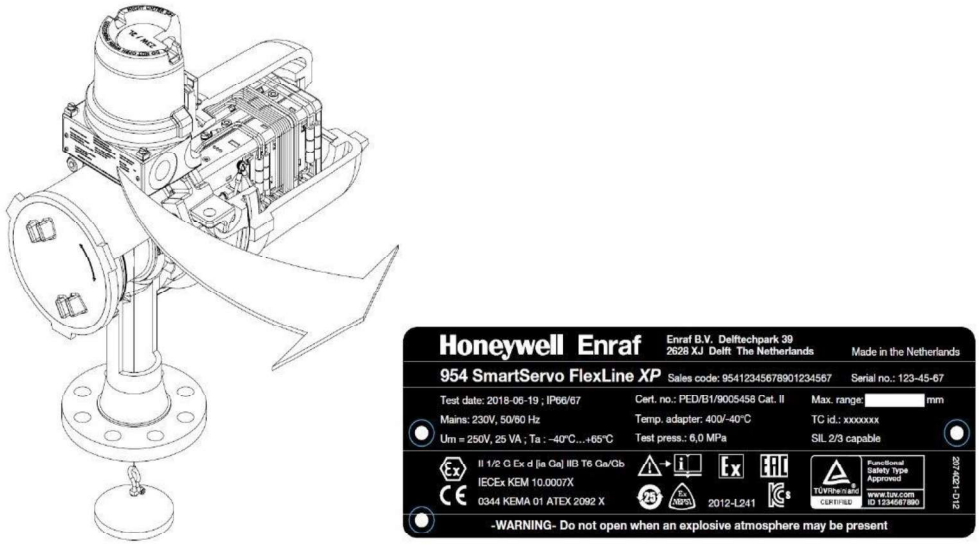


Figure 1 Identification Label with Safety Note on the 954 SmartServo FlexLine

NOTE:
This is a conceptual view of the type plate and therefore subject to change.

2.6. Personal Safety

WARNING!

National, local and company regulations regarding personal safety must be followed.

Pay attention to the kind of product in the tank. If there is any danger for your health, wear a gas mask and take all the necessary precautions.

WARNING!

Take appropriate precautions when chemical or toxic product vapors are present (compressed air, chemical protection suit, and detection equipment).

2.7. Warnings and Cautions

2.7.1. General

2.7.1.1. *Opening of the Instrument*

WARNING!

DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE MAY BE PRESENT.

When it is required to open the instrument in an explosive hazardous environment, take care of the following:

WARNING!

Make sure that the power to the device is switched off before you open the covers of the device. Failure to do so may cause danger to persons or damage the equipment. All covers of the device must be closed before switching the power on again.

WARNING!

Treat the O-ring groove surfaces of the housing with care. Keep the screw threads of the lids free of dirt. Both O-rings must be present and undamaged.

2.7.1.2. *Closing of the Instrument*

Make sure that the O-rings are placed in the groves on the housing (main compartment and the terminal block compartment).

2.7.1.3. *Tools*

WARNING!
Use non-sparking tools and explosion-proof testers.
Use suitable explosion proof tools (for example, testing devices)!

2.7.1.4. *Working Environment*

2.7.1.4.1. Hazardous Area

WARNING!
Potential Electrostatic Charging Hazard!

Avoid generation of static electricity.

2.7.1.4.2. Safe Area

WARNING!
Avoid generation of static electricity. Make sure no explosive gas mixtures are build up in the working area.

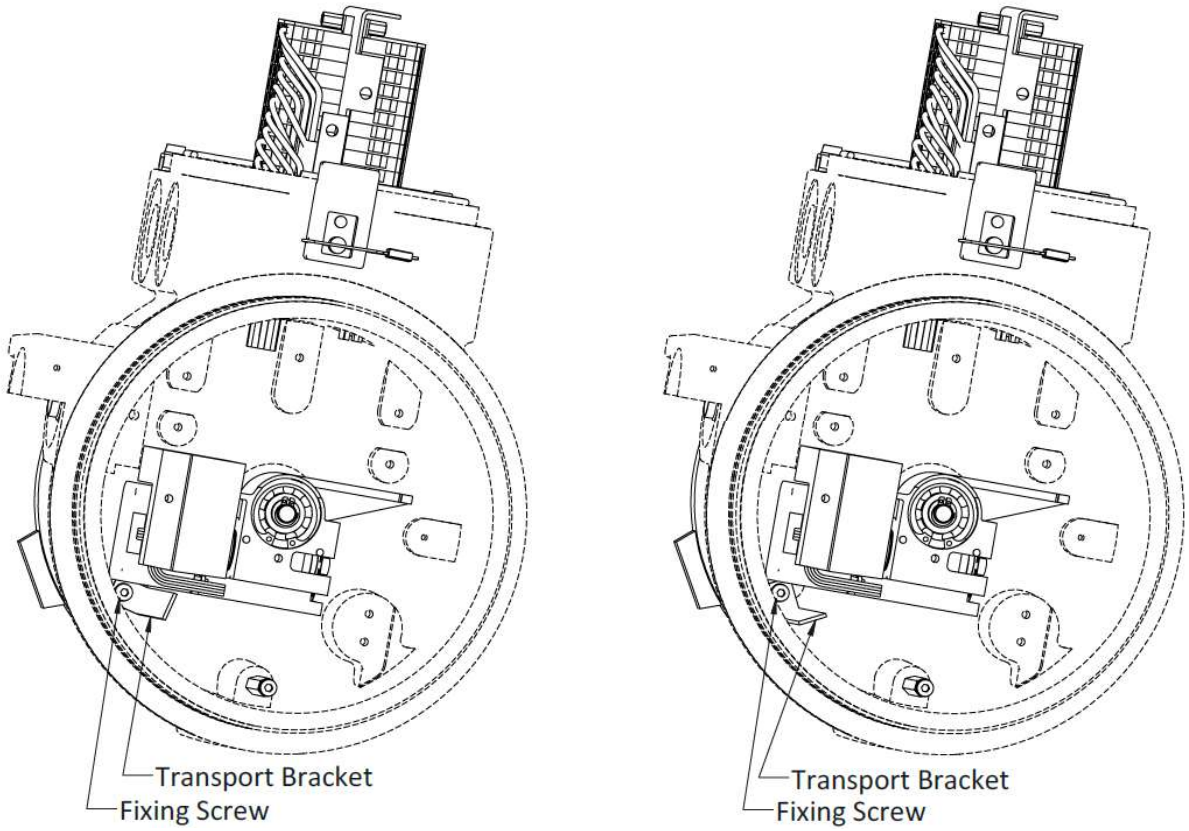
2.7.1.4.3. Required Skills

WARNING!
The technician must be trained and qualified to safely install equipment in hazardous areas. The technician must work in accordance with national, local and company regulations.

2.8. General Precautions

CAUTION!

During transport of the gauge the motor block should be locked. This is for protection of the weighing system.

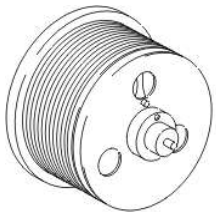


Motor Locked **Motor Unlocked**

Figure 2 Unlocking the 954 SmartServo FlexLine Motor

CAUTION!

The box in which the 954 SmartServo FlexLine arrives also contains the measuring drum. This is a precision measuring device and shall only be installed by a qualified commissioning engineer. Accurate measurement requires an undamaged and clean drum.



Treat this drum with care !

Figure 3 Measuring Drum

Special Tools:

Screw driver for Hex Allen-key screws M4 (length min. 22 mm)

Tommy bar

2.9. Accordance to Regulations

2.9.1. Explosion Safety

- **ATEX**

  II 1/2 G Ex db h IIB T6 Ga/Gb or II 1/2 G Ex db eb h IIB T6 Ga/Gb or II 1/2 G Ex db h [ia Ga] IIB T6 Ga/Gb or II 1/2 G Ex db eb h [ia Ga] IIB T6 Ga

  Certificate no. ATEX: DEKRA 18ATEX0052 X

  IP66/67

- **IECEx**

  Ex db h IIB T6 Ga/Gb or Ex db h eb IIB T6 Ga/Gb or Ex db h [ia Ga] IIB T6 Ga/Gb or Ex db eb h [ia Ga] IIB T6 Ga/Gb

  Certificate no. IECEX: IECEx DEK 18.0033 X

  IP66/67

- **FM**

  XP, Class I, Division 1, Group C,D T6
  AIS, Class I, Division 1, Group C,D
  Ta = -40°C to +65°C
  NEMA 4X
  Certificate no.: FM19US0012

- **CSA**

  Class I, Division 1, Group C,D
  Ex db eb h [ia Ga] IIB T6 Ga/Gb
  Ta = -40°C to +65°C
  Encl 4
  Certificate no.: 70210644

3. PRINCIPAL OF SERVO MEASUREMENT

3.1. Principle of Measurement

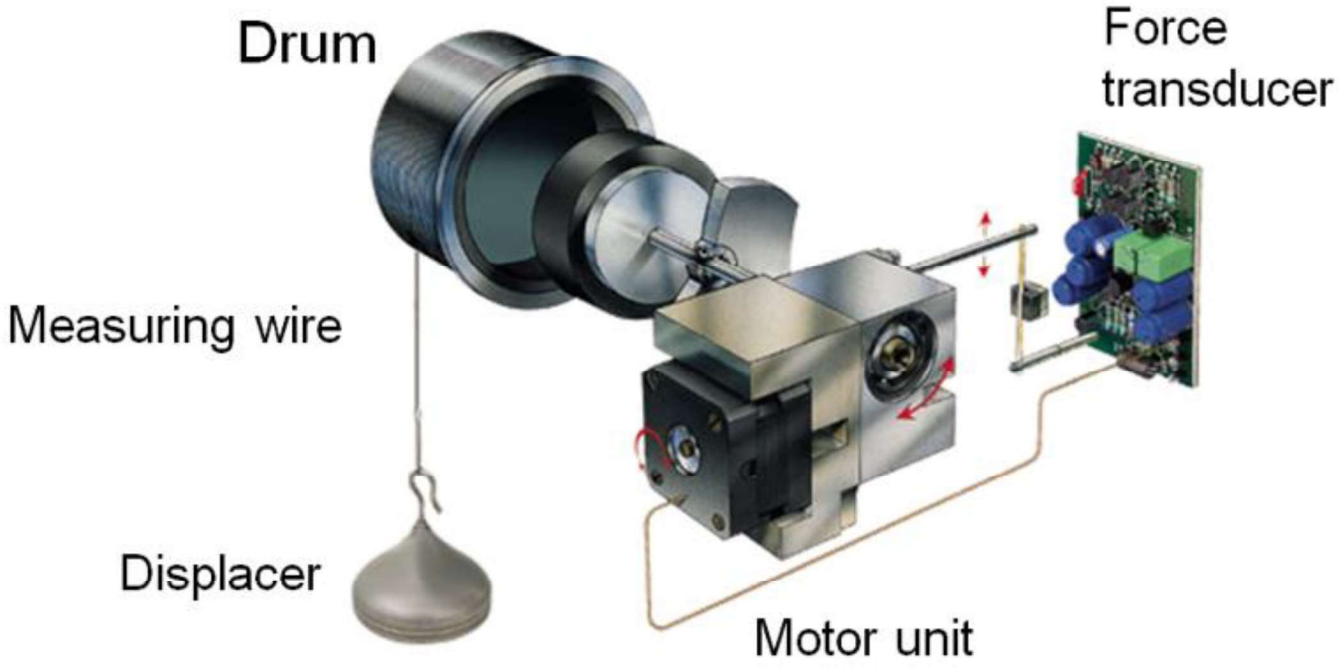


Figure 4 Principle of Measurement

The principle is based on detection of variations in the buoyancy of a displacer. The displacer is suspended from a strong, flexible measuring wire which is stored on a precisely grooved measuring drum.

The shaft of the drum is connected to the stepper motor via a magnetic coupling.

The apparent weight of the displacer is measured by a force transducer. The actual output of the force transducer is compared with a desired value for the apparent weight of the displacer. If a discrepancy exists between measured and desired value, an advanced software control module adjusts the position of the stepper motor.

3.1.1. Level Measurement

A level variation of product, in which the displacer is partially immersed, causes a change in buoyancy, which will be detected by the force transducer. The resulting difference between measured and desired value will cause a variation in the position of the stepper motor and consequently raise or lower the position of the displacer until the measured value equals the desired value.

To avoid oscillations, a certain hysteresis and integration time is software adjustable. This results in a stable and accurate averaged level measurement.

The stepper motor turns one revolution for every 10 mm of vertical movement of the displacer.

One revolution is divided into 200 steps, therefore one step is equivalent to 0.05 mm. This resolution is a direct consequence of the stepper motor principle. The correct functioning of the stepper motor is continuously checked. This is achieved by decoding the unique pattern of an encoder disk mounted on the motor shaft.

3.1.2. Interface between two Products

Measurement of the interface between two products is achieved by sending an interface command to the gauge. This causes the stepper motor processor to move the displacer to a position where the apparent weight of the displacer matches a pre-programmed set point.

3.1.3. Relative Density

To measure the relative density, the displacer is positioned at specific heights and the apparent weight of the displacer at each height is measured. Knowing the volume of the displacer, its weight in air, and the measured apparent weight, the relative density of the product at each position of the displacer can be calculated. The software for the density measurement is available as an option.

4. MECHANICAL INSTALLATION

4.1. Preparation for Transportation of the Gauge

CAUTION!
Do not transport the instrument with the motor unlocked. Refer to Figure 2 for motor locking.

Drum should be transported in original protective box. Drum and displacer shall only be installed by a qualified commissioning engineer.

4.2. Process Connection

The 954 SmartServo FlexLine can be ordered with raised face or flat face flange. Select gasket that is suitable for flange type, maximum pressure and product to be stored. Mount instrument flange horizontally.

WARNING!
Verify that tank or drum compartment is depressurized before opening the tank or drum compartment cover of 954 SmartServo FlexLine.

The 954 SmartServo FlexLine can be adapted to various process connection flanges via adapters/calibration chambers as specified in Appendix B. Verify that maximum working pressure of adapter/calibration chamber complies with pressure in your tank.

WARNING!
954 SmartServo FlexLine gauge should be mounted as horizontal as possible. Installation under an angle might influence accuracy of the gauge.

NOTE:
When using 954 SmartServo FlexLine on pressurized tank, it is recommended to install a suitable valve between tank and 954 SmartServo FlexLine to isolate the instrument from the process when required.

The valve shall have an opening large enough to feed through the displacer.

4.3. Orientation of 954 SmartServo FlexLine Gauge on Tank

Mount the gauge in one of the following two ways:

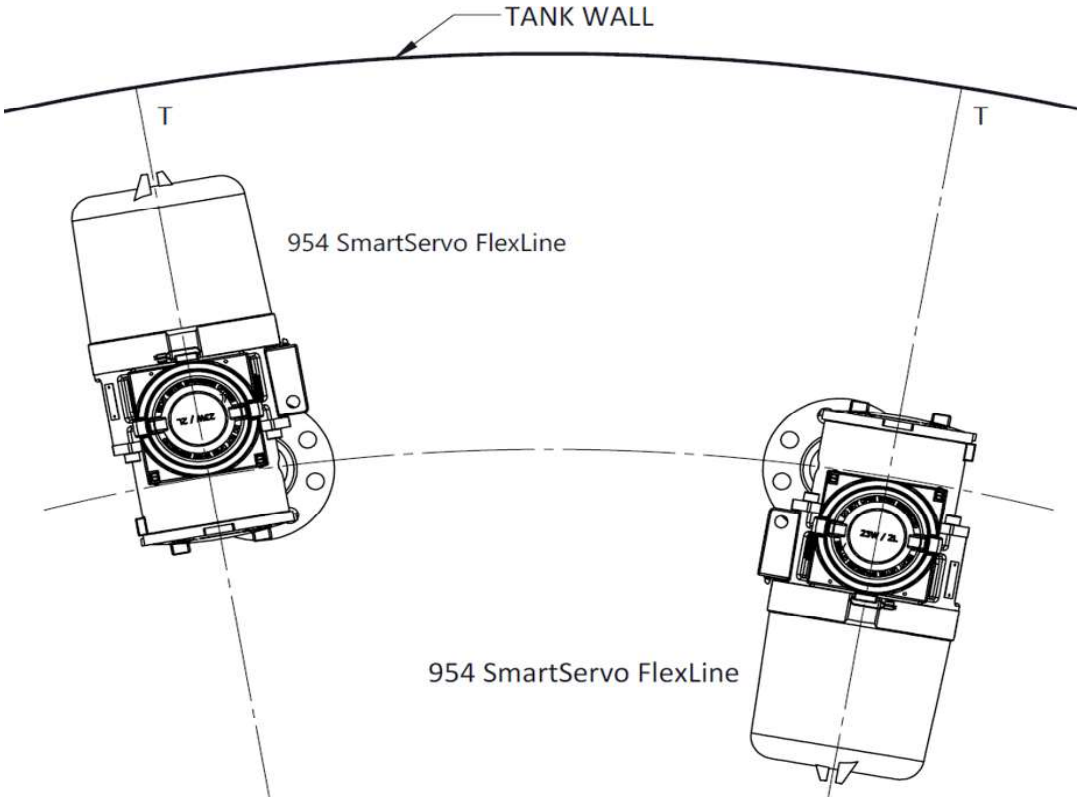


Figure 5 Orientation of the Gauge on a Tank (top view)

On a stilling well or guide pole, the orientation of the gauge may be chosen freely.

NOTE:

The weight of the 954 SmartServo FlexLine for:

- medium pressure version is : 16 kg (35 lbs);

- chemical version is : 21 kg (46 lbs);

- high pressure version is : 26 kg (57 lbs).

WARNING!
Use the Hoisting Eye for lifting up the 954 SmartServo FlexLine versions above 18 kg (see picture Appendix A)

4.4. **Bolts**

Secure the gauge adapter by using appropriate bolts. *)

Flange type	Number of bolts	Diameter x minimum
NW50, ND6	4	M12 x 50
NW50, ND40	4	M16 x 60
2", 150 lbs	4	$^5/_8$" x 3" (M16 x 80)
2", 300 lbs	8	$^5/_8$" x 3" (M16 x 80)
6", 150 lbs	8	$^3/_4$" x 3$^1/_4$" (M20 x 80)
6", 300 lbs	12	$^3/_4$" x 4" (M20 x 100)

*) Bolt dimensions (acc. to DIN 2527, ANSI B16.5) are given in the table.

4.5. **Mounting a Pressure Gauge Set**

1. Connect T-piece horizontally to drum house.
2. Check whether manometer is suitable for the maximum pressure in the tank.
3. Mount manometer and vent valve (Figure 6).
4. Close vent valve.
5. Gently open valve between tank and drum compartment and check for leakage on all connections.

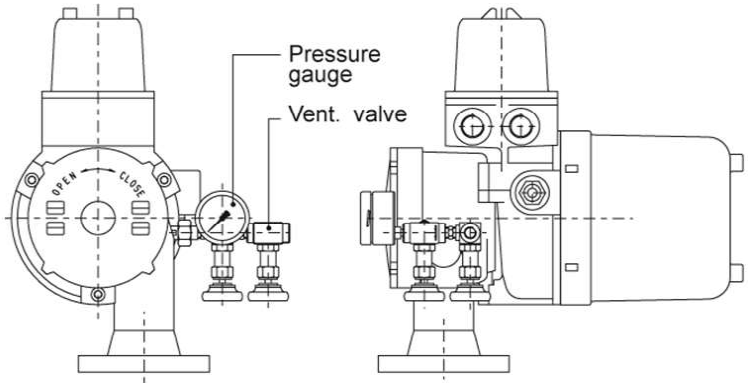


Figure 6 Mounting a Pressure Gauge Set on a 954 SmartServo FlexLine Gauge

4.6. **Grounding**

WARNING!
For proper grounding of the 954 SmartServo FlexLine, install a copper strip under one of the flange bolts for each flange. Place shark rings between flange and strip (Figure 7).

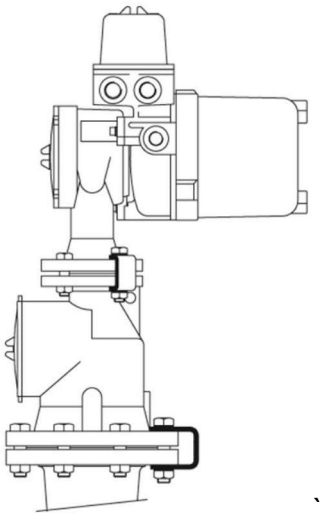


Figure 7 Example of Flange Ground

NOTE:
Also in case of tanks with cathodic protection, the 954 SmartServo FlexLine must be grounded to the tank. Cathodic protection can be maintained by isolating the cable screen/armouring or conduit.

5. ELECTRICAL INSTALLATION

5.1. General

The entire installation procedure must be carried out in accordance with national, local, and company regulations. The entire electrical installation shall be carried out in accordance with the national requirements for electrical equipment to be installed in hazardous areas.

- All wiring entries must be closed such that the approvals are not invalidated.
- Use at least increased safety (Ex e) cable glands.
- Ex d cable glands are allowed to be used as well.
- For installations using conduits, each conduit must be sealed within 18 inches of the enclosure.
- Improper installation of cable glands, conduits or stopping plugs invalidates the Ex approval of this device.
- Make sure that the housing of the device is properly bonded to the Protective Earth (PE).

WARNING!
Cables and cable glands for at least 105 °C (221 °F) shall be used. When the ambient temperature is known to be always less than 50 °C (122 °F), cables and cable glands for at least 90 °C (194 °F) can be used.

5.2. Grounding

WARNING!
Make sure the housing of the device is properly connected to the ground reference! Make sure the electrical resistance of the ground connection is below the maximum prescribed by local requirements!

WARNING!
The instrument may not be opened when an explosion atmosphere may be present. Failure to do so may cause danger to persons or damage the equipment.

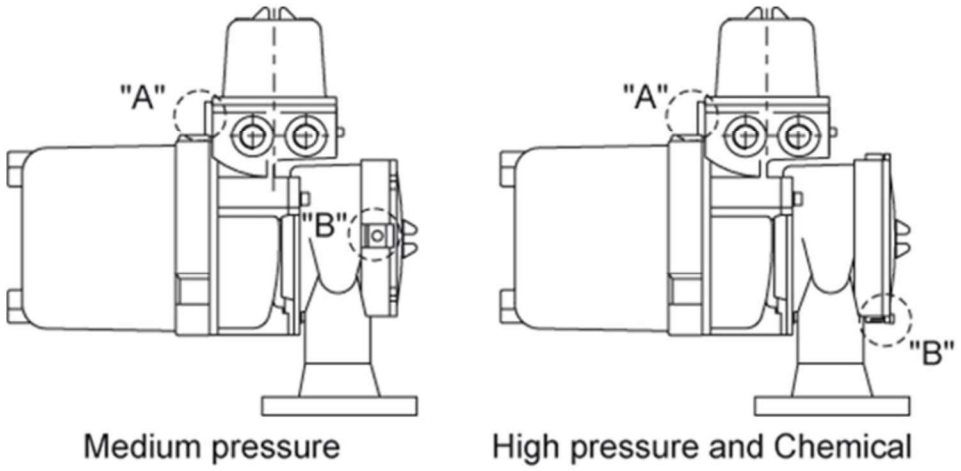


Figure 8 Optional Blocking Devices

CAUTION

CAUTION!
Before opening the electronic and terminal compartment cover, remove the optional blocking devices which locks the covers: "A": for electronic compartment cover and terminal compartment cover; "B": for drum compartment cover.

CAUTION

CAUTION!
Do not damage the thread of the covers and instrument and keep the thread free of dirt.

After opening, grease it lightly with anti-seize grease.

When closing, never tighten the covers before the threads are properly engaged. The covers should be turned counter-clockwise until the thread clicks in place, then turn clockwise until the covers are fully closed.

After closing the covers, do not forget to place the blocking devices.

5.3. **Safety**

5.3.1. General Relative Density

WARNING!
Make sure the power to the device is switched OFF, before you open the cover of the device.

CAUTION!
Do not make any additional holes in the housing.

WARNING!
Make sure that no explosive gas mixtures build up in the working area.

5.4. Installing the Cable Glands and Stopping Plugs

WARNING!
Only use Ex e or flameproof certified materials of an appropriate IP value.

CAUTION!
Improper installation of cable glands or stopping plugs will invalidate the Ex approval of the 954 SmartServo FlexLine.

5.4.1. Cable Glands

Use Ex e or Ex d 3/4" NPT cable glands (or where applicable equivalent conduit connections) with an appropriate IP value. See the type plate on the device.

NOTE:
Install the cable glands according to the instructions provided by the manufacturer.

5.4.2. Unused Cable Inlets

Seal unused cable inlets with approved ¾" NPT threaded stopping plugs.

5.5. Installing the Glands, Conduits and Stopping Plugs

CAUTION!
Improper installation of cable glands, conduits, or stopping plugs will invalidate the Ex approval of the 954 SmartServo FlexLine.

5.5.1. Conduits

Use explosion proof (Ex d) conduits with an appropriate IP value. See the type plate on the device.

WARNING!
If the 954 SmartServo FlexLine is installed in a hazardous area:
Metal conduits must be used, size 3/4".

Stopper boxes must be installed within 45 cm (18") of the device to seal the cabling in the conduit.

NOTE:
Install the conduits according to the instructions provided by the manufacturer.

5.5.2. Unused Cable Inlets

Seal unused cable inlets with approved ¾" NPT threaded stopping plugs.

5.6. **Electrical Connections**

CAUTION!
Cables must always comply with the defined cable specifications.

5.6.1. Grounding

The 954 SmartServo FlexLine housing must be properly grounded to the ground reference (generally the tank), according to local regulations. This is a safety grounding requirement.

WARNING!
When measuring the ground resistance, use a suitable instrument that is approved for use in hazardous areas.

WARNING!
Safety depends on proper grounding. Check the resistance of the ground connection directly after installation. The measured ground resistance must be below the maximum prescribed by local and/or national grounding requirements.

5.6.2. Connections

WARNING!
The intrinsically safe options have been certified for use in hazardous areas. Make sure that the certificate of approval is available on site and act in accordance with the instructions as given in the certificate.

WARNING!
Intrinsically safe wiring must be separated from all other wiring. The cable lay-out must be in accordance with local and/or national regulations.

NOTE:
Connect the armoring of the cable externally in the cable gland at both ends of the cable

The terminal compartment is located at the top of the device (see Figure 10) and it is divided into two zones:

- Blue terminals, for intrinsically safe connections, such as HART, VITO, RTD, MRT / MPT and HART SmartView.
- Grey terminals, for non-intrinsically safe connections.

The indices of the terminals are variable. They are specified in a label attached in front of the terminal row, as is schematically indicated in Figure 11.

5.6.2.1. *General Procedure*

Connect the wiring to the terminals with the numbers as shown in the tables in the following sections.

5.6.2.2. *954 SmartServo FlexLine Board Overview*

CAN-Servo, CAN-PSS, CAN-HART, and CAN-LCD boards are part of each 954 SmartServo FlexLine device. All remaining boards mentioned in this Installation Manual are optional (see Figure 9).

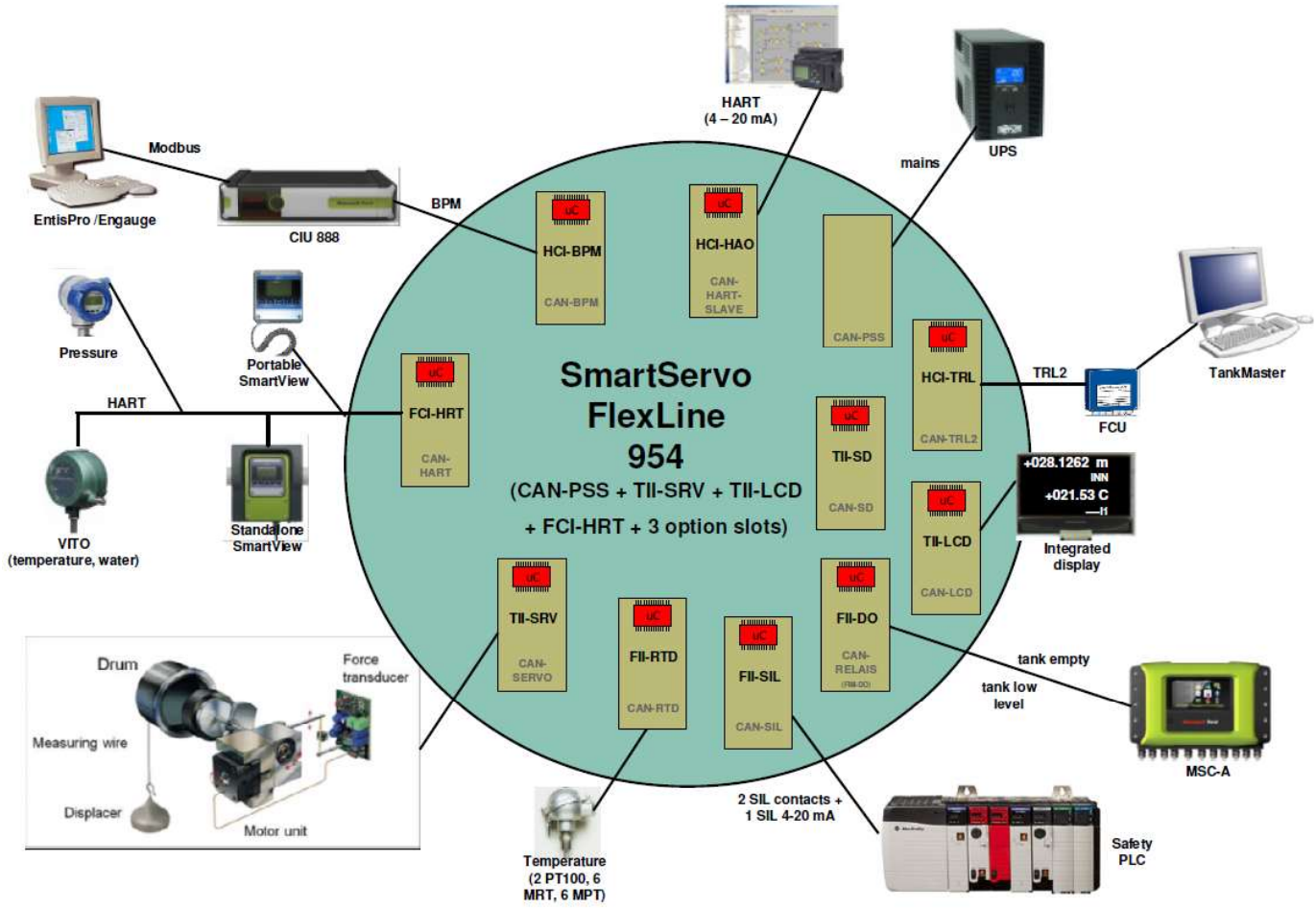


Figure 9 954 SmartServo FlexLine Board Overview

5.6.2.3. *Non-intrinsically Safe Connections*

The non-intrinsically safe connections are connected to the grey wiring terminal.

If local and or national regulations allow, the power supply, Enraf fieldbus, and hardware relay outputs may be combined into one, unshielded, cable.

A separate cable may also be used for each.

5.6.2.4. *Lay-out Terminal Compartment*

The terminal compartment on top of the 954 SmartServo FlexLine is divided into a non-intrinsically safe and an intrinsically safe part. Cable entries are ¾" NPT.

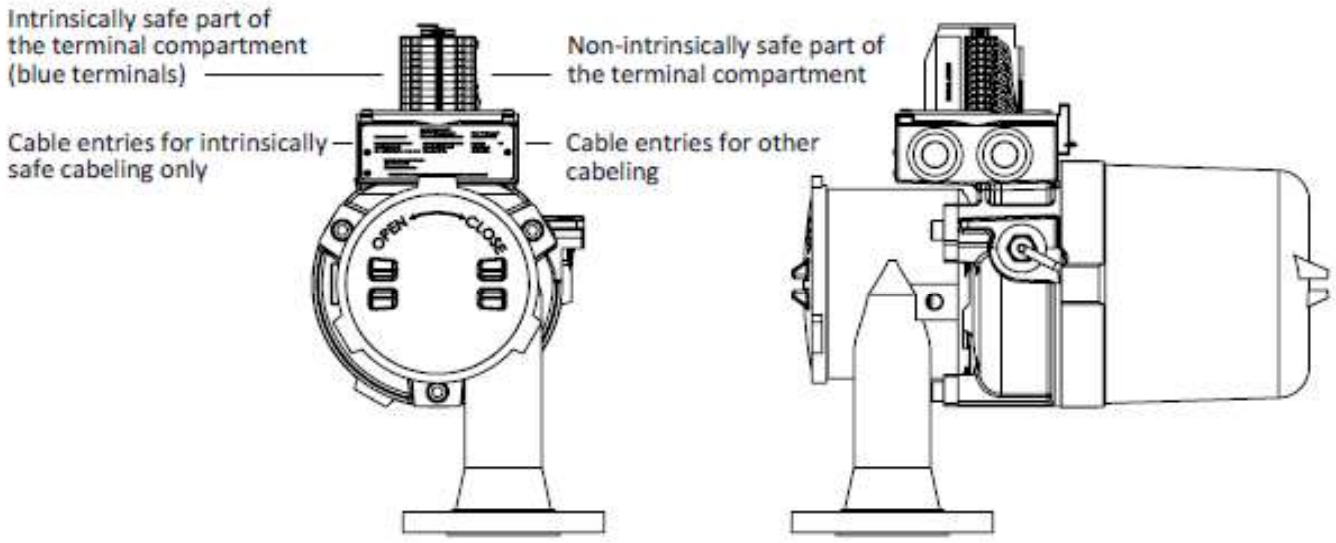


Figure 10 Intrinsically Safe and Non-Intrinsically Safe Cable Entries

The non-intrinsically safe cabling may only enter at the two right hand side cable entries (Figure 10).

WARNING!
The Instrument may not be opened when an explosive atmosphere may be present.

5.6.2.5. *Non-intrinsically Safe Cabling*

Mains cabling: Must be suitable for the 954 SmartServo FlexLine power rating and, moreover, approved for the use in hazardous areas.

Honeywell Enraf field bus lines may be interchanged. If local regulations allow, mains and Honeywell Enraf field bus lines may share one cable.

Mind the isolation voltage of the cores in the cable; refer to the International Standard IEC 61010-1.

NOTE:
If a quad cable is used and all four cores are twisted together, use two opposite cores for Honeywell Enraf field bus lines and the two others for mains.

Terminal information:

Solid / stranded	: 0.5…6 / 1.5…4
Flexible / stranded wire with end	: 0.5…4 / 0.5…2.5
Tightening torque range (clamping)	: 0.6…0.8 Nm (M 3)
Stripping length / Blade size	: 8 / 0.6 x 3.5 mm

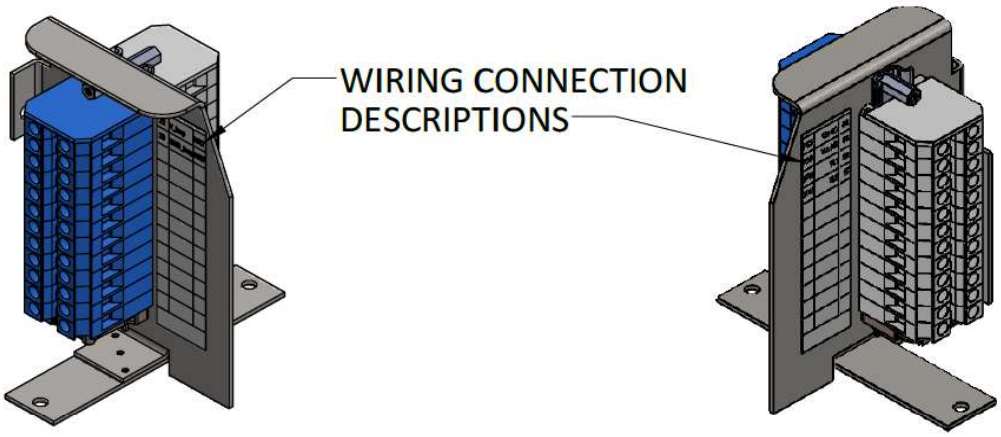


Figure 11 Wiring Connection Descriptions

5.6.2.6. *Power Supply (CAN-PSS)*

Connect the power supply to either:

- DC: 24 - 65 Volt
- AC: 65 - 240 Volt

NOTE:
The DC polarity is not critical.

NOTE:
Disconnection from the supply source needs to be performed externally with an easy accessible and clearly marked switch or circuit breaker as disconnecting device and shall disconnect all current carrying conductors.

5.6.2.7. *Cable Specifications*

Cable specifications	
Type	Suitable for the 954 SmartServo FlexLine power rating, and approved for use in hazardous areas

Label	**Parameters**
00. Vin-a/L	24-65 Vdc -15/+10% 65-240 Vac -15/+10% 50/60 Hz ± 10% Automatic selection
01. Vin-b/N	

5.6.2.8. *Enraf Fieldbus (Bi Phase Mark) (CAN-BPM)*

Cable specifications	
Type	Twisted pair; R_{max} = 200 Ohm /line, C_{max} = 1 µF.
Maximum length	10 km

Label	**Parameters**
06.or 08 TL1	1200/2400/4800 bps Selection by software
07.or 09 TL2	

A maximum of 10 devices can be connected to the Enraf field bus line.

For short distances up to 20 devices can be connected. This number will be specific to every situation.

5.6.2.9. *Emerson TRL/2 Field Bus (CAN-TRL2)*

Cable specifications	
Type	18 AWG (minimum) with shielded twisted pair, with max 8 multi drop Gauge connections
Maximum length	4 km

Label	**Parameters**
06. or 08 TL1	4800 bps
07. or 09 TL2	

5.6.2.10. *Alarm Relay Outputs (CAN-RELAIS)*

The hardware relay outputs can be used as an alarm signal or to operate a remote device.

The signals corresponding with the terminal labels are programmed during commissioning.

Cable specifications	
Type	Approved for use in hazardous areas and suitable for the specified power rating.

Label	**Parameters**
14. Ry1_a	Vmax = 125 Vac, Imax = 0.5 A, via double isolated transformer
15. Ry1_b	Vmax = 110 Vdc, Imax = 0.3 A, Pmax = 30 W NO/NC by factory jumper
16. Ry2_a	Vmax = 125 Vac, Imax = 0.5 A, via double isolated transformer
17. Ry2_b	Vmax = 110 Vdc, Imax = 0.3 A, Pmax = 30 W NO/NC by factory jumper (default = NO)

Label	Parameters
18. Ry3_a 19. Ry3_b	Vmax = 150 Vac, Imax = 3 A, Vmax = 40 Vdc, Imax = 3 A, Pmax = 450 W NO/NC by factory jumper
20. Ry4_a 21. Ry4_b	Vmax = 150 Vac, Imax = 3 A, Vmax = 40 Vdc, Imax = 3 A, Pmax = 450 W NO/NC by factory jumper

5.6.2.11. *SIL Overfill and Underfill Protection (CAN-SIL)*

Label	Parameters
50. AO-PAS + 51. AO-COM 52. AO-ACT -	Iin / Iout = 1 ….24 mA Vin / Vout = 10…24.5 V

If the sensor powers the loop connect sensor between terminals 50 AO-Pas + and 51 AO-ACT –

If the Servo powers the loop connect sensor between terminals 51 AO-COM + and 52 AO-ACT –

Label	Parameters
54. DO1_a 55. DO1_b	Vmax = 250 Vac, Imax = 2 A Vmax = 40 Vdc, Imax = 2 A Pmax = 500 W
56. DO2_a 57. DO2_b	Vmax = 250 Vac, Imax = 2 A Vmax = 40 Vdc, Imax = 2 A Pmax = 500 W

5.6.2.12. *HART and Analog Output (CAN-HART-SLAVE)*

Cable specifications	
Type	Shielded twisted pair
Maximum length	1200 meter

Label	Parameters
46 or 48 4-20 mA +	Iloop 0 to 25 mA
47 or 49 4-20 mA -	Vmax 55 Volts

5.6.2.13. *VITO Temperature, HART Slave and SmartView (CAN-HART)*

NOTE:
Intrinsically Safe Connections

The intrinsically safe connections are connected to the blue wiring terminals.

VITO (for temperature and water bottom measurement)

Cable specifications	
Type	Twisted pair, shielded. R_{max} = 25 Ω / line
Maximum length	1000 meter

Label	Parameters	
22. V_Loop	[Ex ia] IIB	*The I/O shall not be accessible or shall be isolated in the end use.*
23. GND_Loop	Uo = 23.1 V	*Ensure the end user cannot touch these wires when energized.*
	Uo = 23.1 V	
	Io = 124 mA	
	Po = 0.6 W	
	Co = 1.0 µF	

HART Transmitters

Cable specifications	
Type	Twisted pair, shielded. R_{max} = 25 Ω / line
Maximum length	1000 meter

Label	Parameters
24. V_Loop	[Ex ia] IIB *The I/O shall not be accessible or shall be isolated in the end use.*
25. GND_Loop	Uo = 23.1 V *Ensure the end user cannot touch these wires when energized.* Io = 124 mA Po = 0.6 W Co = 1.0 µF Lo = 9 mH

Stand-alone HART SmartView Display

Cable specifications	
Type	Twisted pair, shielded. R_{max} = 25 Ω / line
Maximum length	1000 meter

Refer to HART Communication Foundation document number HCF_SPEC-54 (FSK Physical Layer Specification) for detailed length calculations.

Connection Table

Label 954 SmartServo FlexLine	Parameters 954 SmartServo FlexLine	Label HART SmartView	Parameters HART SmartView
24. V_loop	[ia Ga] IIB T6 Ga/ Gb	2. Loop +	[Ex ia] IIB T4 Gb
25. GND_Loop	Uo = 23.1 V	1. Loop -	Ui = 30 V
	Io = 124 mA		Ii = 200 mA
	Po = 0.6 W		Pi = 0.7 W
	Co = 1.0 µF		Ci = 10 nF
	Lo = 9 mH		Li = 16 µH

The I/O shall not be accessible or shall be isolated in the end use. Ensure the end user cannot touch these wires when energized.

5.6.2.14. *Topology*

Terminals for HART and VITO are combined. A maximum of 4 HART devices, or 2 HART devices if VITO is present, can be connected to the HART connection.

CAUTION

CAUTION!
Before connecting the HART devices:

Make sure the sum of the start-up currents fits the parameters.

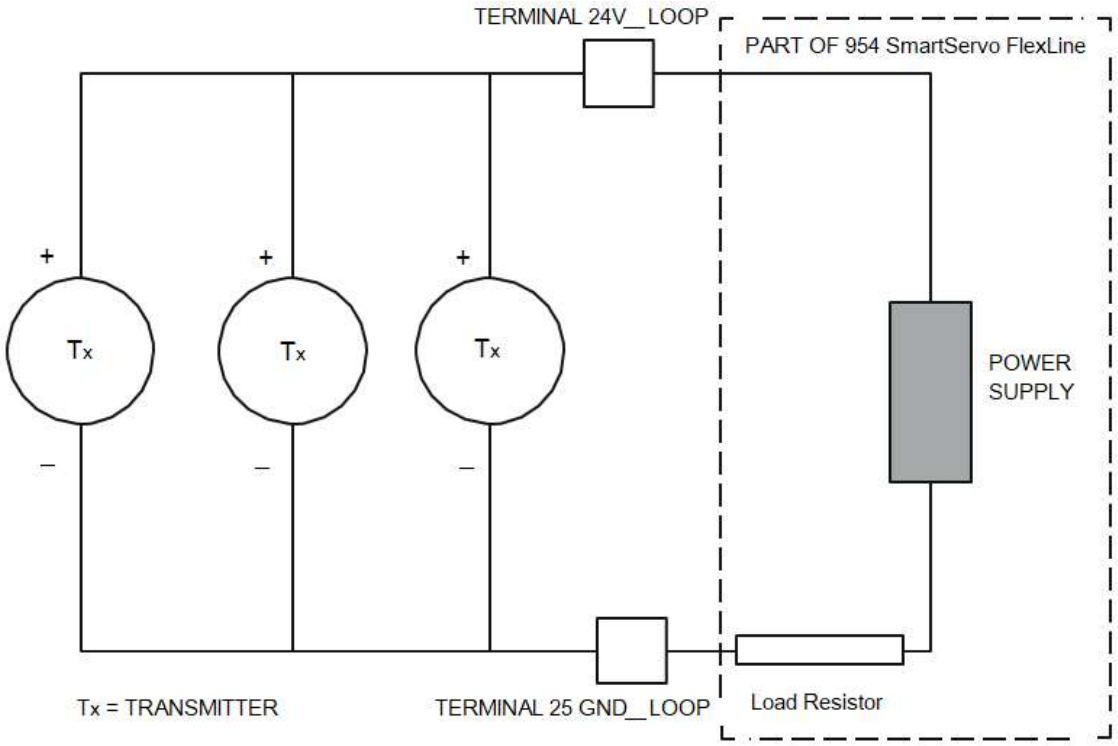
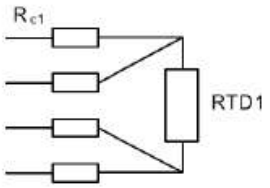
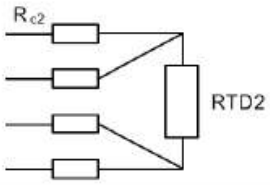


Figure 12 Topology

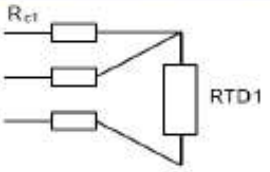
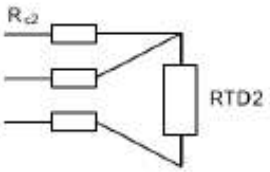
5.6.2.15. *RTD, MRT, MPT Temperature Measurement (CAN-RTD)*

Cable specifications	
Type	Shielded. R_{max} = 100 Ω / line
Maximum length	150 meter

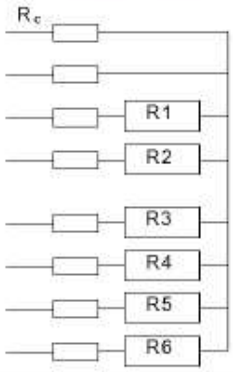
RTD, 4-Wire Connection

Label	Connections diagram	Parameters
30. RTD1_S-		[Ex ia] IIB/IIC U_o = 8.61 V I_o = 58 mA P_o = 0.13 W C_o = 1.0 µF L_o = 10.5 mH *The I/O shall not be accessible or shall be isolated in the end use. Ensure the end user cannot touch these wires when energized*
31. RTD1_com		
32. RTD1_pos		
33. RTD1_S+		
34. RTD2_S-		
35. RTD2_com		
36. RTD2_pos		
37. RTD2_S+		

RTD, 3-Wire Connection

Label	Connections diagram	Parameters
30. RTD1_S-		[Ex ia] IIB/IIC U_o = 8.61 V I_o = 58 mA P_o = 0.13 W C_o = 1.0 µF L_o = 10.5 mH *The I/O shall not be accessible or shall be isolated in the end use. Ensure the end user cannot touch these wires when energized*
31. RTD1_com		
32. RTD1_pos		
34. RTD2_S-		
35. RTD2_com		
36. RTD2_pos		

MPT – MRT

Label	Connections diagram	Parameters
38. S-		[Ex ia] IIB/IIC U_o = 8.61 V I_o = 58 mA P_o = 0.13 W C_o = 1.0 µF L_o = 10.5 mH *The I/O shall not be accessible or shall be isolated in the end use. Ensure the end user cannot touch these wires when energized*
39. com		
40. R1		
41. R2		
42. R3		
43. R4		
44. R5		
45. R6		

5.7. Finishing Installation

CAUTION!
Make sure the separation between intrinsic and non intrinsic cabling is sufficient and complies with any local and/or national regulations.

5.7.1. Assembling the Terminal Block and Board Compartment's Lids

WARNING!
Make sure the surface of the O-ring grooves of the housing are clean and the O-rings are not damaged before assembling the lids to the 954 SmartServo FlexLine housing.

Make sure that the both lids (used for terminal block and board compartments) do not squeeze any cables during the assembly.

NOTE:
If existing installations have terminals 22 (V_Loop) and 23 (GND_Loop), VITO must be connected between them.

5.8. External Fusing

The 954 SmartServo FlexLine external fuses must be installed in the mains supply cable to each 954 SmartServo FlexLine.

mains voltage	fuse value (in accordance with IEC 127-2-3)
220 Vac or 230 Vac	315 mA slow
110 Vac or 130 Vac	630 mA slow
65 Vac	1 A slow

5.9. Cable Glands / Conduit

Explosion-proof (Ex d) or increased safe (Ex e) cable glands must be used, depending on local requirements. Refer to the Ex-marking on the identification label of the 954 SmartServo FlexLine to determine which type of cable glands is required.

NOTE:
Mount the glands according to the supplier's instructions.

Conduit:

If the 954 SmartServo FlexLine is installed in a hazardous area, threaded rigid metal conduit or threaded steel intermediate metal conduit shall be used.

NOTE:
If the 954 SmartServo FlexLine is installed in a hazardous area, Ex d certified conduit seals must be applied directly at the wall of the 954 SmartServo FlexLine to seal the cabling in the conduit.

Depending on the wiring configuration, one to four ¾" NPT threaded cable glands (or rigid conduits) may be required with the 954 SmartServo FlexLine.

NOTE:
Seal the unused cable inlets with an approved ¾" NPT threaded stopping plug.

WARNING!
Improper installation of cable glands, conduit or stopping plugs will invalidate the Ex approval of your 954 SmartServo FlexLine.

5.10. Grounding

The 954 SmartServo FlexLine housing should be properly grounded to the ground reference (generally the tank).

This is a safety grounding requirement. Grounding can be performed by copper strips across the flanges (refer to section Grounding at mechanical installation), or by a ground wire.

With last mentioned method, use one of the external ground terminals of the 954 SmartServo FlexLine.

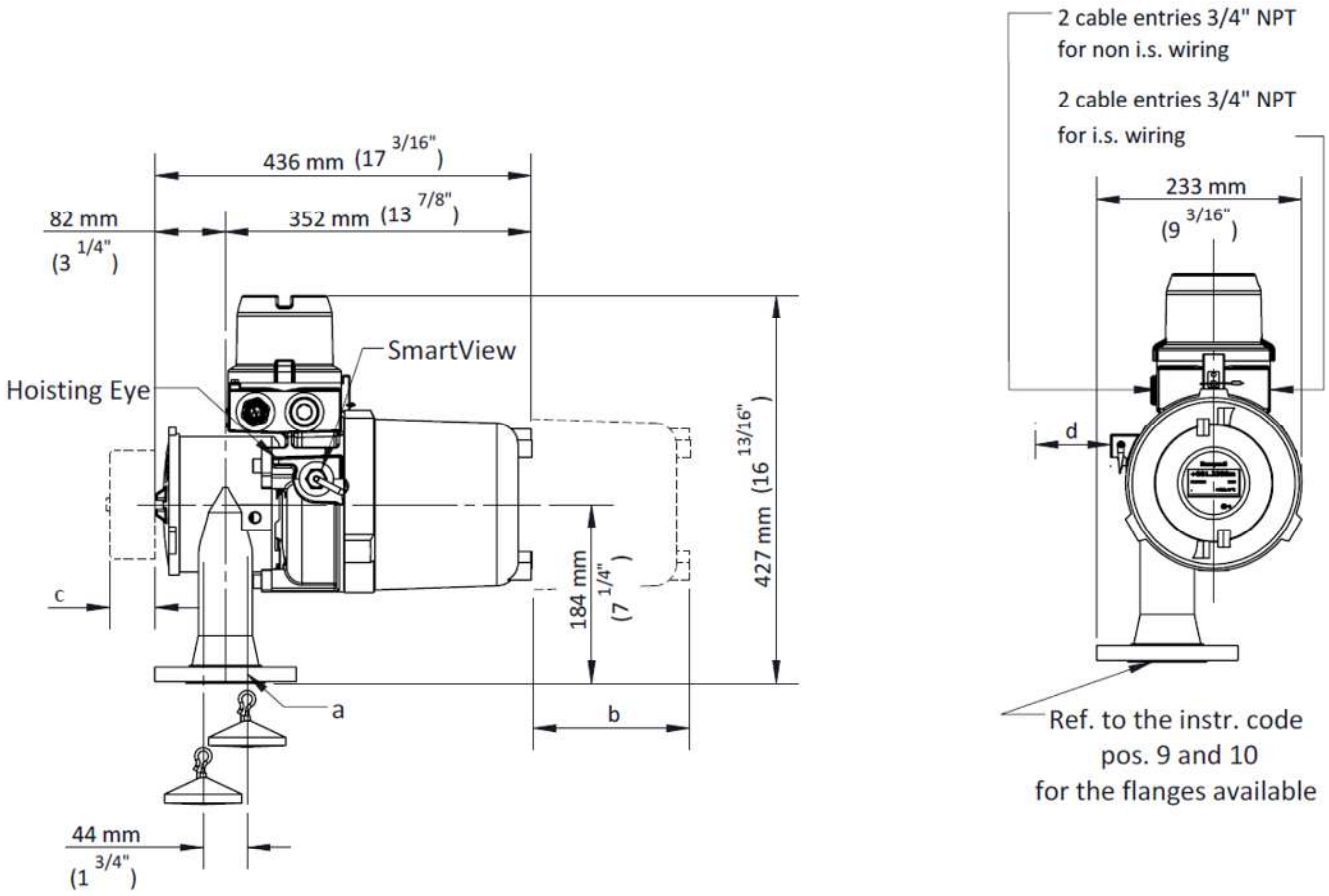
NOTE:
Grounding shall be performed in accordance with local regulations.

CAUTION!
Safety depends on proper grounding. Check the resistance of the ground connection directly after installation. The measured ground resistance shall be below the maximum prescribed by local grounding requirements.

WARNING!
When measuring the ground resistance, use a suitable explosion-proof tester.

Appendix A

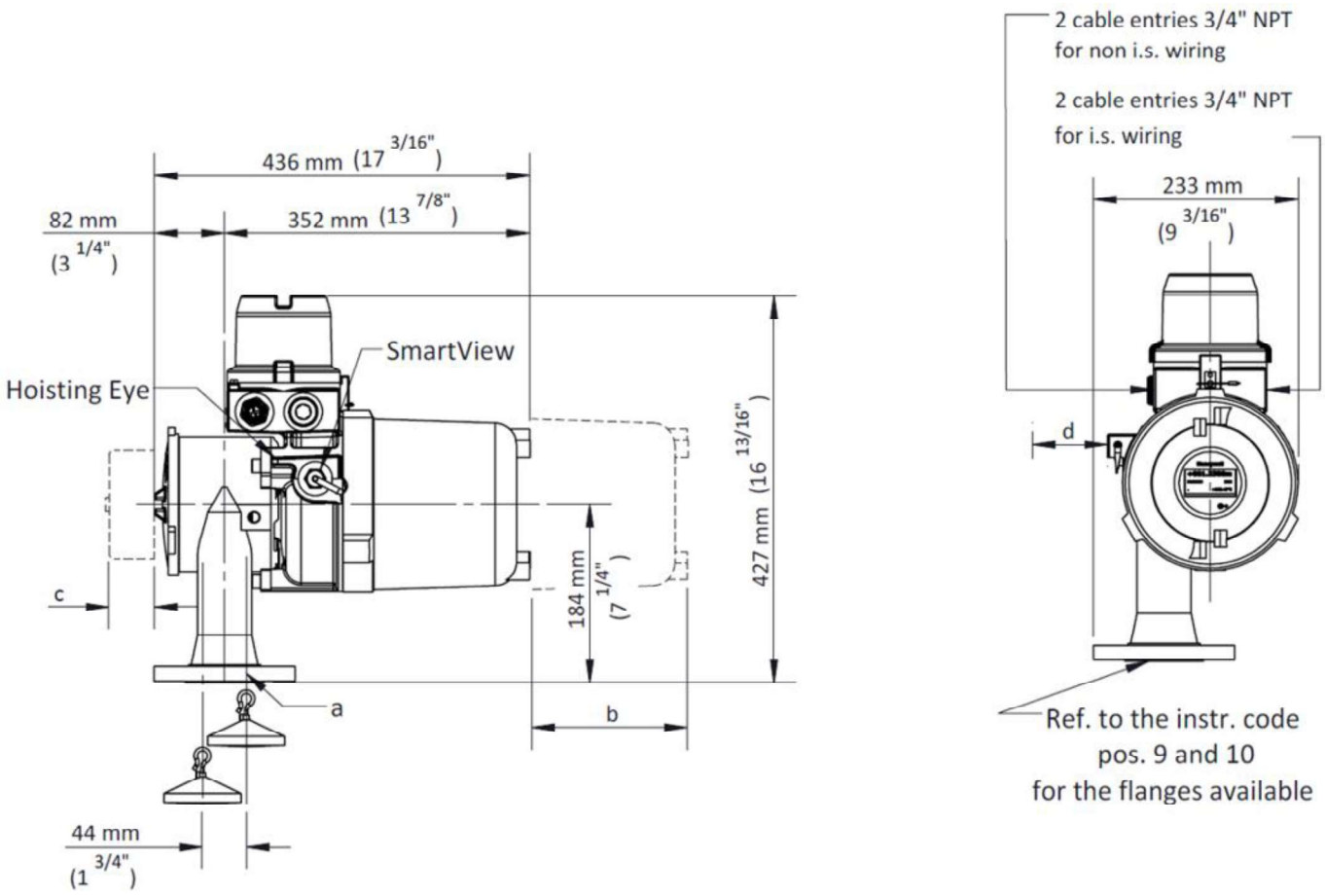
Dimensions 954 SmartServo FlexLine (Medium Pressure and Chemical Version)



a. Position of measuring wire with displacer in top position
b. 200 mm (7 7/8") (space needed to remove cover)
c. 65 mm (2 9/16") (space needed to remove measuring drum)
d. 100 mm (4") (free space for SmartView Connection)

Appendix A (Continuation)

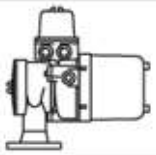
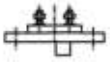
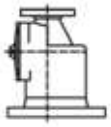
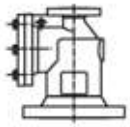
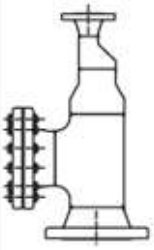
Dimensions 954 SmartServo FlexLine (High Pressure Version)



a. Position of measuring wire with displacer in top position
b. 200 mm (7 7/8") (space needed to remove cover)
c. 65 mm (2 9/16") (space needed to remove measuring drum)
d. 100 mm (4") (free space for SmartView Connection)

Appendix B

Available Adapters & Calibration Chambers

Orientation	Specifications		
	Orientation of adapters, reducers and calibration chambers with respect to the 854 ATG as drawn. Asymmetrical adapters must be mounted in the right way with respect to the 854 gauge in order to prevent malfunctioning of the gauge. For symmetrical adapters the orientation is insignificant.		
	**Flange adapter** for medium pressure		
	2" to 6", 150 lbs, ff (aluminium, 3.2371)	Height: 48 mm (1 7/8")	Part no.: 0815.092
	NW50-ND6 to NW150-ND16, ff (aluminium, 3.2371)	Height: 48 mm (1 7/8")	Part no.: 0815.093
	2" to 6", 150 lbs, ff (AISI 316, 1.4401)	Height: 48 mm (1 7/8")	Part no.: 0815.095
	**Calibration adapter** for medium pressure 0.6 MPa (88 psi)		
	2" to 6", 150 lbs (aluminium, 3.2371)	Height: 307 mm (12 1/16")	Part no.: 0815.091
	2" to 8", 150 lbs (aluminium, 3.2371)	Height: 307 mm (12 1/16")	Part no.: 0815.096
	NW50-ND6 to NW150-ND16 (aluminium, 3.2371)	Height: 307 mm (12 1/16")	Part no.: 0815.094
	2" to 6", 150 lbs (stainless st. ASTM A 351 CF8M, 1.4408)	Height: 288 mm (11 3/8")	Part no.: 0815.086
	**Calibration adapter** for high pressure 4 MPa (590 psi)		
	2" to 6", 300 lbs (Stainless st. ASTM A351 CF8M, 1,4408)	Height: 344 mm (13 9/16")	Part no.: 0815.534
	NW50-ND40 to NW150-ND40 (Stainless st. ASTM A351 CF8M, 1,4408)	Height: 344 mm (13 9/16")	Part no.: 0815.532
	**Adapter** for medium pressure		
	2" to 4", 150 lbs	Height: 241 mm (9 1/2")	
	for high pressure		
	2" to 4", 300 lbs	Height: 257 mm (10 1/8")	
	**Adapter** for medium pressure		
	2" to 6", 150 lbs	Height: 392 mm (15 7/16")	
	2" to 8", 150 lbs	Height: 417 mm (16 7/16")	
	for high pressure		
	2" to 6", 300 lbs	Height: 410 mm (16 1/8")	
	2" to 8", 300 lbs	Height: 435 mm (17 1/8")	
	**Adapter** for medium pressure		
	2" to 4" with 4" blind flange, 150 lbs	Height: 451 mm (17 3/4")	
	2" to 6" with 4" blind flange, 150 lbs	Height: 679 mm (26 3/4")	
	2" to 8" with 6" blind flange, 150 lbs	Height: 775 mm (30 1/2")	
	for high pressure		
	2" to 4" with 4" blind flange, 300 lbs	Height: 467 mm (18 3/8")	
	2" to 6" with 4" blind flange, 300 lbs	Height: 695 mm (27 3/8")	
	2" to 8" with 6" blind flange, 300 lbs	Height: 791 mm (31 1/8")	
	* Mat.: Flanges ASTM A 105, Grade N Body : ASTM A 105, Grade N		

For service-related questions, contact:

Technical Assistance Centre
Phone:
+1 800 423 9883 or +1 215 641 3610
E-mail:
HFS-TAC-SUPPORT@honeywell.com

For more information
To learn more about SmartLine Transmitters,
visit **www.honeywellprocess.com**
Or contact your Honeywell Account Manager

Process Solutions
Honeywell
1250 W Sam Houston Pkwy S
Houston, USA, TX 77042

Honeywell Control Systems Ltd
Honeywell House, Skimped Hill Lane
Bracknell, England, RG12 1EB

Shanghai City Centre, 100 Jungi Road
Shanghai, China 20061

www.honeywellprocess.com

4417341 Rev.10
March 2019

Honeywell

Installation Manual
954 SmartServo FlexLine

For service related questions contact:

Head Office - Delft, The Netherlands

Honeywell Enraf
Delftechpark 39, 2628 XJ Delft
PO Box 812, 2600 AV Delft
The Netherlands

Tel.: +31 (0)15 2701 100
Fax: +31 (0)15 2701 111

E-mail: HFS-TAC-Support@Honeywell.com
Website: www.honeywellprocess.com

About this manual

This manual provides information related to installation of the 954 SmartServo FlexLine.

For servicing of the device refer to the 954 SmartServo FlexLine Service Manual listed below in References.

For Safety instructions and procedures refer to the 954 SmartServo FlexLine Safety manual listed below in References.

Introduction

The 954 SmartServo FlexLines an automatic tank gauge measuring the surface or interface level of crude oil or derived products stored in a bulk storage tank. Typically those storage tanks are available on terminals, production plants and refineries in the petro chemical, oil and gas industry. The environment on those sites is typically explosion hazardous.

The end user will typically use the 954 SmartServo FlexLine together with a Terminal Inventory System for custody transfer operations, therefore Weights and Measures legislation is applicable.

The 954 SmartServo FlexLine is based on the modular FlexConn board architecture. Every FlexConn board supported in this device is described in detail.

Revision History

954 Installation Manual (This document)

4417341	00	9th November 2018 (1st Release)
4417341	01	20th November 2018 (Updated the document)
4417341	02	22nd November 2018 (Updated the document)
4417341	03	23rd November 2018 (Finalized the document)
4417341	04	29th November 2018 (Added Relay Output Section)
4417341	05	29th November 2018 (Updated Pmax on Relay Output)
4417341	06	10th December 2018 (Updated pages 21 and 32)
4417341	07	10th January 2019 (Added FM information on page 16)
4417341	08	17th January 2019 (Added temperature range on page 16)
4417341	09	23rd January 2019 (Added I/O text to tables on page 35, 36, 38 & 39)
4417341	10	12th March 2019 (Added CSA information on page 16)

References

The following list identifies publications that may contain information relevant to the information in this document.

4417340	1	954 Service Manual
4417342	1	954 Safety Manual

Patents

The Honeywell 954 SmartServo FlexLine servo-based level gauge is covered by the following patents:

US2017307461 (A1) 2017-10-26, US2018058960 (A1) 2018-03-01

WO2017062413 (A1) 2017-04-13, WO2018044518 (A1) 2018-03-18

Contents

Figure

1. GENERAL

1.1. Using this Installation Guide

The 954 SmartServo FlexLine is used in measurement systems for inventory measurement and control. The 954 SmartServo FlexLine can integrate data from other measurement devices, such as temperature RTD sensors.

Data from 954 SmartServo FlexLine and connected sensors can be communicated to host computer systems via a variety of industry standard protocols.

1.2. Related Documents

- 954 SmartServo FlexLine Safety instructions for installation, commissioning, operation, and maintenance; shipped with the device
- CE Declaration of Conformity
- EC-Type Examination Certificate
- IEC-Ex Certificate of Conformity
- Control drawings for FM and CSA

1.3. Trademarks

HART® is a registered trademark of the HART Communication Foundation.

1.4. Contact

Head Office - Delft, The Netherlands
Honeywell Enraf
Delftechpark 39, 2628 XJ Delft
PO Box 812, 2600 AV Delft
The Netherlands

Tel.: +31 (0)15 2701 100
Fax: +31 (0)15 2701 111
E-mail: enraf.helpdesk@honeywell.com
Website: http://www.honeywell.com/ps

2. SAFETY AND SECURITY

2.1. General

The 954 SmartServo FlexLine is a servo-based level gauge which is used in inventory measurement systems. It can also be used to interface with other systems and sensors such as pressure, density, or temperature sensors.

For the correct and safe servicing of this product, it is essential that all personnel follow the generally accepted safety procedures in addition to the safety precautions specified in this manual.

2.2. Safety Conventions

2.2.1. WARNINGS

The following warning symbol is used in this manual to urge attention in order to **prevent personal injuries** or **dangerous situations**, further described in this manual.

Symbol	Description	Remark
	*General warning*	*Will always be explained by text.*

2.2.2. CAUTIONS

The following caution mark is used in this manual to urge attention in order ***to prevent damages to the equipment*** further described in this manual.

Symbol	Description	Remark
	*General caution sign*	

2.3. Safety Instructions

2.3.1. Safety Instructions

See the safety instructions shipped with the device for installation, commissioning, operation, and maintenance.

2.3.2. EC Declaration of Conformity (for EU)

Refer to the EC declaration of conformity shipped with the device.

2.3.3. Control Drawings for FM & CSA

Refer to the control drawings shipped with the device.

2.3.4. Users

The mechanical and electrical installation must be carried out only by trained personnel with knowledge of the requirements for installation of explosion-proof equipment in hazardous areas.

The entire installation procedure must be carried out in accordance with national, local, and company regulations.

The entire electrical installation shall be carried out in accordance with the national requirements for electrical equipment to be installed in hazardous areas.

NOTE:
See EN IEC 60079-14 or NEC (NFPA70).

2.3.5. Additional Information

If you require additional information, contact Honeywell or its representative.

2.3.6. Environmental Conditions

Observe the environmental conditions for the temperature and the pressure.

Ambient Operating Temperature Range from -40°C (-40°F) up to +65°C (149°F).

2.4. **Liability**

The information in this Installation Manual is the copyright property of Honeywell. Honeywell disclaims any responsibility for personal injury or damage to equipment caused by:

- Deviation from any of the prescribed procedures,
- Execution of activities that are not prescribed,
- Neglect of the safety regulations for handling tools and use of electricity.

The contents, descriptions and specifications in this Installation Manual are subject to change without notice. Honeywell accepts no responsibility for any errors that may appear in this Installation Manual.

WARNING!
Only certified technicians are authorized to make changes on the 954 SmartServo FlexLine configuration. All modifications must be in accordance to the guidelines as set forth by Honeywell. Modifications not authorized by Honeywell will invalidate the approval certificates.

2.5. **Labels**

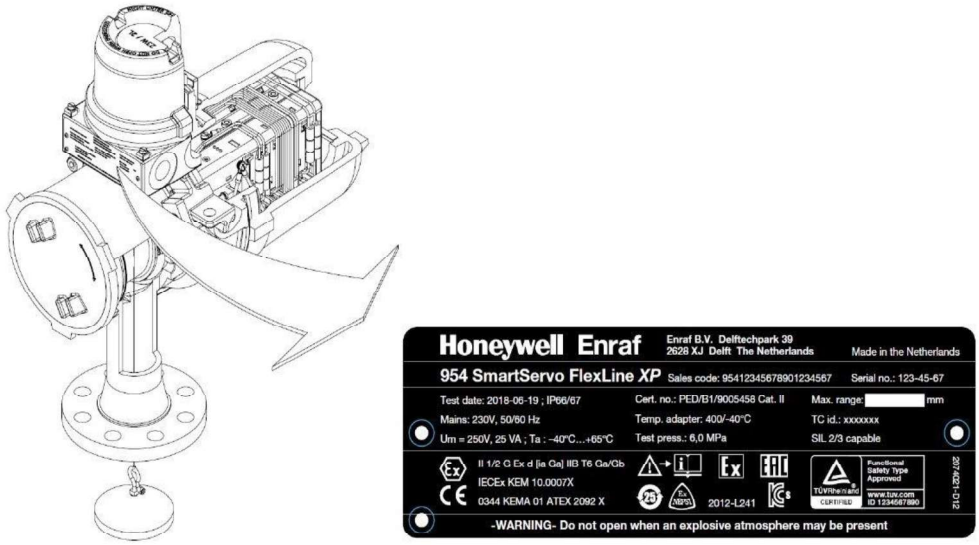


Figure 1 Identification Label with Safety Note on the 954 SmartServo FlexLine

NOTE:
This is a conceptual view of the type plate and therefore subject to change.

2.6. Personal Safety

WARNING!

National, local and company regulations regarding personal safety must be followed.

Pay attention to the kind of product in the tank. If there is any danger for your health, wear a gas mask and take all the necessary precautions.

WARNING!

Take appropriate precautions when chemical or toxic product vapors are present (compressed air, chemical protection suit, and detection equipment).

2.7. Warnings and Cautions

2.7.1. General

2.7.1.1. *Opening of the Instrument*

WARNING!

DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE MAY BE PRESENT.

When it is required to open the instrument in an explosive hazardous environment, take care of the following:

WARNING!

Make sure that the power to the device is switched off before you open the covers of the device. Failure to do so may cause danger to persons or damage the equipment. All covers of the device must be closed before switching the power on again.

WARNING!

Treat the O-ring groove surfaces of the housing with care. Keep the screw threads of the lids free of dirt. Both O-rings must be present and undamaged.

2.7.1.2. *Closing of the Instrument*

Make sure that the O-rings are placed in the groves on the housing (main compartment and the terminal block compartment).

2.7.1.3. *Tools*

WARNING!
Use non-sparking tools and explosion-proof testers.
Use suitable explosion proof tools (for example, testing devices)!

2.7.1.4. *Working Environment*

2.7.1.4.1. Hazardous Area

WARNING!
Potential Electrostatic Charging Hazard!

Avoid generation of static electricity.

2.7.1.4.2. Safe Area

WARNING!
Avoid generation of static electricity. Make sure no explosive gas mixtures are build up in the working area.

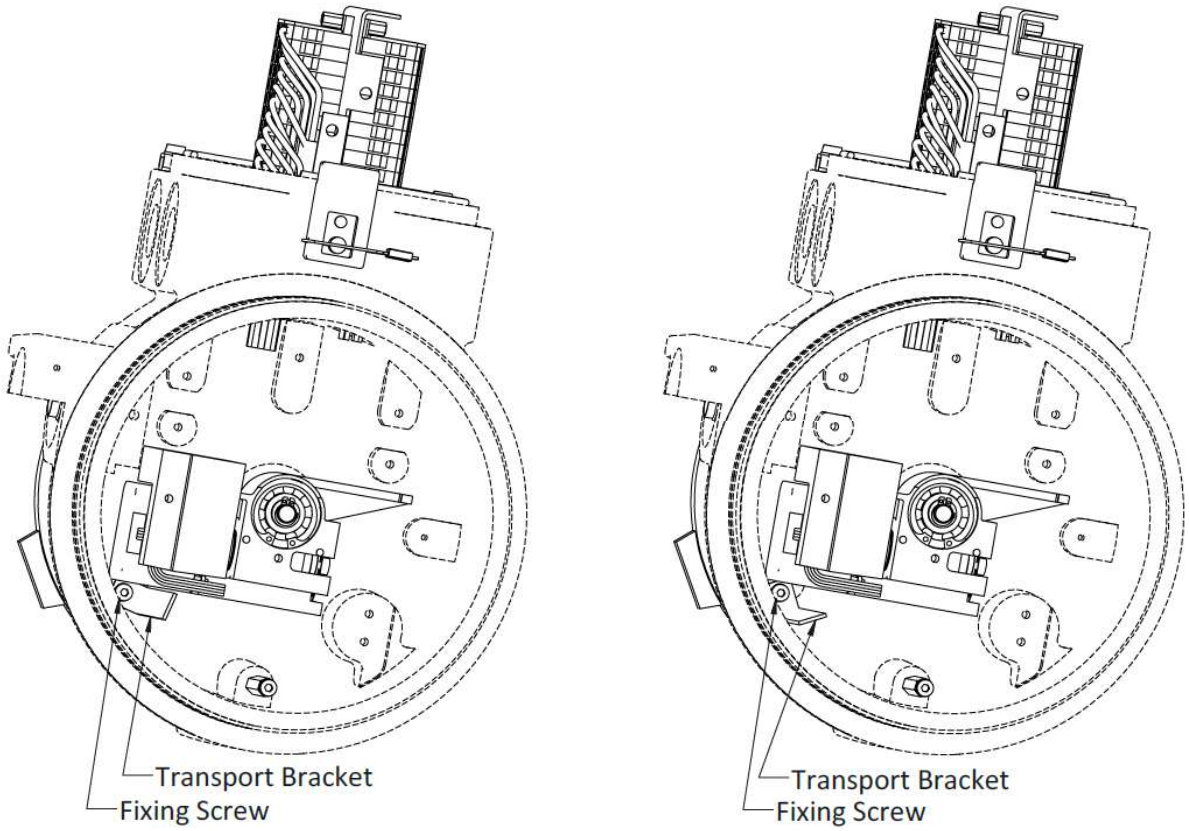
2.7.1.4.3. Required Skills

WARNING!
The technician must be trained and qualified to safely install equipment in hazardous areas. The technician must work in accordance with national, local and company regulations.

2.8. General Precautions

CAUTION!

During transport of the gauge the motor block should be locked. This is for protection of the weighing system.

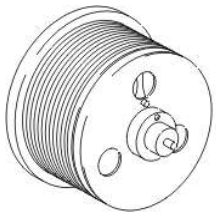


Motor Locked **Motor Unlocked**

Figure 2 Unlocking the 954 SmartServo FlexLine Motor

CAUTION!

The box in which the 954 SmartServo FlexLine arrives also contains the measuring drum. This is a precision measuring device and shall only be installed by a qualified commissioning engineer. Accurate measurement requires an undamaged and clean drum.



Treat this drum with care !

Figure 3 Measuring Drum

Special Tools:

Screw driver for Hex Allen-key screws M4 (length min. 22 mm)

Tommy bar

2.9. Accordance to Regulations

2.9.1. Explosion Safety

- **ATEX**

  II 1/2 G Ex db h IIB T6 Ga/Gb or II 1/2 G Ex db eb h IIB T6 Ga/Gb or II 1/2 G Ex db h [ia Ga] IIB T6 Ga/Gb or II 1/2 G Ex db eb h [ia Ga] IIB T6 Ga

  Certificate no. ATEX: DEKRA 18ATEX0052 X

  IP66/67

- **IECEx**

  Ex db h IIB T6 Ga/Gb or Ex db h eb IIB T6 Ga/Gb or Ex db h [ia Ga] IIB T6 Ga/Gb or Ex db eb h [ia Ga] IIB T6 Ga/Gb

  Certificate no. IECEX: IECEx DEK 18.0033 X

  IP66/67

- **FM**

  XP, Class I, Division 1, Group C,D T6
  AIS, Class I, Division 1, Group C,D
  Ta = -40°C to +65°C
  NEMA 4X
  Certificate no.: FM19US0012

- **CSA**

  Class I, Division 1, Group C,D
  Ex db eb h [ia Ga] IIB T6 Ga/Gb
  Ta = -40°C to +65°C
  Encl 4
  Certificate no.: 70210644

3. PRINCIPAL OF SERVO MEASUREMENT

3.1. Principle of Measurement

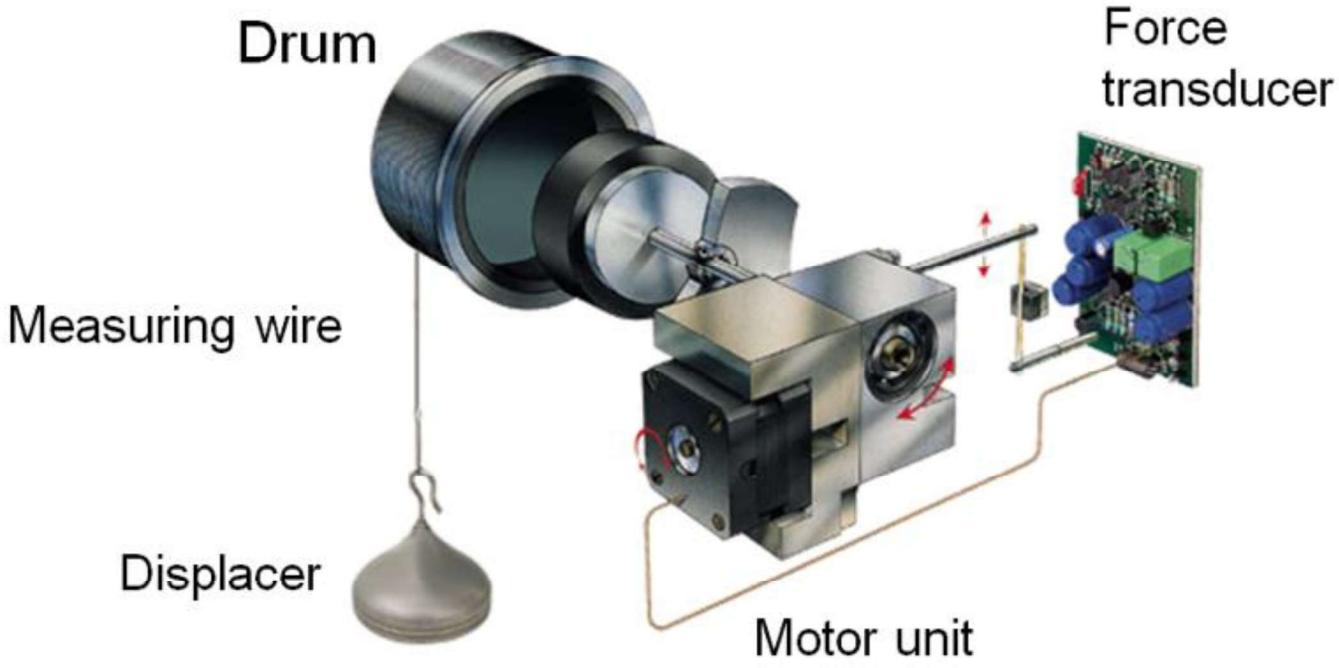


Figure 4 Principle of Measurement

The principle is based on detection of variations in the buoyancy of a displacer. The displacer is suspended from a strong, flexible measuring wire which is stored on a precisely grooved measuring drum.

The shaft of the drum is connected to the stepper motor via a magnetic coupling.

The apparent weight of the displacer is measured by a force transducer. The actual output of the force transducer is compared with a desired value for the apparent weight of the displacer. If a discrepancy exists between measured and desired value, an advanced software control module adjusts the position of the stepper motor.

3.1.1. Level Measurement

A level variation of product, in which the displacer is partially immersed, causes a change in buoyancy, which will be detected by the force transducer. The resulting difference between measured and desired value will cause a variation in the position of the stepper motor and consequently raise or lower the position of the displacer until the measured value equals the desired value.

To avoid oscillations, a certain hysteresis and integration time is software adjustable. This results in a stable and accurate averaged level measurement.

The stepper motor turns one revolution for every 10 mm of vertical movement of the displacer.

One revolution is divided into 200 steps, therefore one step is equivalent to 0.05 mm. This resolution is a direct consequence of the stepper motor principle. The correct functioning of the stepper motor is continuously checked. This is achieved by decoding the unique pattern of an encoder disk mounted on the motor shaft.

3.1.2. Interface between two Products

Measurement of the interface between two products is achieved by sending an interface command to the gauge. This causes the stepper motor processor to move the displacer to a position where the apparent weight of the displacer matches a pre-programmed set point.

3.1.3. Relative Density

To measure the relative density, the displacer is positioned at specific heights and the apparent weight of the displacer at each height is measured. Knowing the volume of the displacer, its weight in air, and the measured apparent weight, the relative density of the product at each position of the displacer can be calculated. The software for the density measurement is available as an option.

4. MECHANICAL INSTALLATION

4.1. Preparation for Transportation of the Gauge

CAUTION!
Do not transport the instrument with the motor unlocked. Refer to Figure 2 for motor locking.

Drum should be transported in original protective box. Drum and displacer shall only be installed by a qualified commissioning engineer.

4.2. Process Connection

The 954 SmartServo FlexLine can be ordered with raised face or flat face flange. Select gasket that is suitable for flange type, maximum pressure and product to be stored. Mount instrument flange horizontally.

WARNING!
Verify that tank or drum compartment is depressurized before opening the tank or drum compartment cover of 954 SmartServo FlexLine.

The 954 SmartServo FlexLine can be adapted to various process connection flanges via adapters/calibration chambers as specified in Appendix B. Verify that maximum working pressure of adapter/calibration chamber complies with pressure in your tank.

WARNING!
954 SmartServo FlexLine gauge should be mounted as horizontal as possible. Installation under an angle might influence accuracy of the gauge.

NOTE:
When using 954 SmartServo FlexLine on pressurized tank, it is recommended to install a suitable valve between tank and 954 SmartServo FlexLine to isolate the instrument from the process when required.

The valve shall have an opening large enough to feed through the displacer.

4.3. Orientation of 954 SmartServo FlexLine Gauge on Tank

Mount the gauge in one of the following two ways:

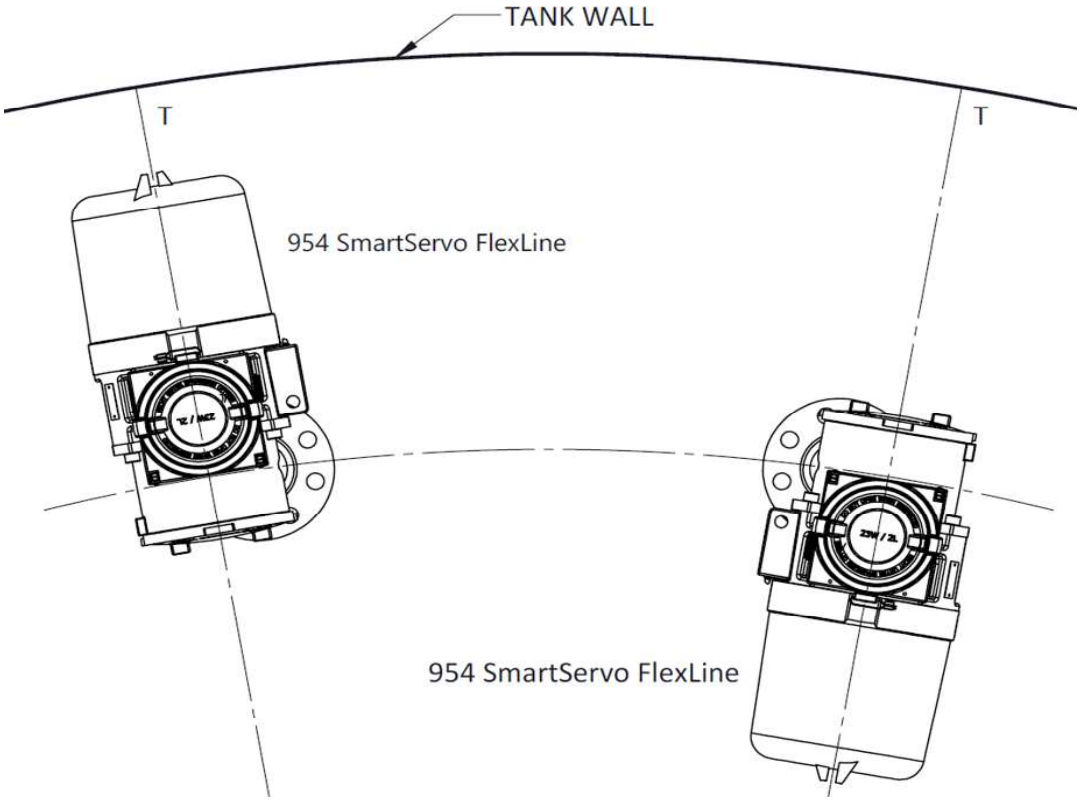


Figure 5 Orientation of the Gauge on a Tank (top view)

On a stilling well or guide pole, the orientation of the gauge may be chosen freely.

NOTE:

The weight of the 954 SmartServo FlexLine for:

- medium pressure version is : 16 kg (35 lbs);

- chemical version is : 21 kg (46 lbs);

- high pressure version is : 26 kg (57 lbs).

WARNING!
Use the Hoisting Eye for lifting up the 954 SmartServo FlexLine versions above 18 kg (see picture Appendix A)

4.4. **Bolts**

Secure the gauge adapter by using appropriate bolts. *)

Flange type	Number of bolts	Diameter x minimum
NW50, ND6	4	M12 x 50
NW50, ND40	4	M16 x 60
2", 150 lbs	4	$^5/_8$" x 3" (M16 x 80)
2", 300 lbs	8	$^5/_8$" x 3" (M16 x 80)
6", 150 lbs	8	$^3/_4$" x 3$^1/_4$" (M20 x 80)
6", 300 lbs	12	$^3/_4$" x 4" (M20 x 100)

*) Bolt dimensions (acc. to DIN 2527, ANSI B16.5) are given in the table.

4.5. **Mounting a Pressure Gauge Set**

1. Connect T-piece horizontally to drum house.
2. Check whether manometer is suitable for the maximum pressure in the tank.
3. Mount manometer and vent valve (Figure 6).
4. Close vent valve.
5. Gently open valve between tank and drum compartment and check for leakage on all connections.

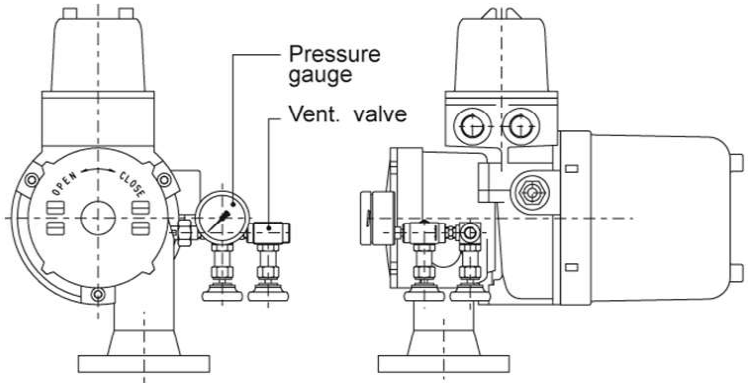


Figure 6 Mounting a Pressure Gauge Set on a 954 SmartServo FlexLine Gauge

4.6. **Grounding**

WARNING!
For proper grounding of the 954 SmartServo FlexLine, install a copper strip under one of the flange bolts for each flange. Place shark rings between flange and strip (Figure 7).

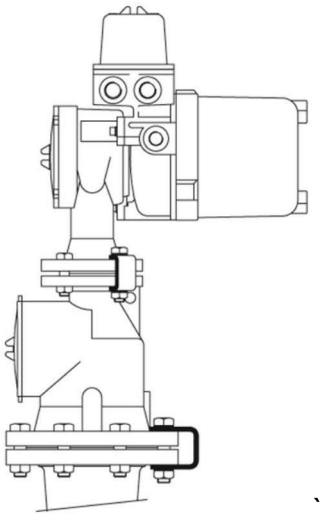


Figure 7 Example of Flange Ground

NOTE:
Also in case of tanks with cathodic protection, the 954 SmartServo FlexLine must be grounded to the tank. Cathodic protection can be maintained by isolating the cable screen/armouring or conduit.

5. ELECTRICAL INSTALLATION

5.1. General

The entire installation procedure must be carried out in accordance with national, local, and company regulations. The entire electrical installation shall be carried out in accordance with the national requirements for electrical equipment to be installed in hazardous areas.

- All wiring entries must be closed such that the approvals are not invalidated.
- Use at least increased safety (Ex e) cable glands.
- Ex d cable glands are allowed to be used as well.
- For installations using conduits, each conduit must be sealed within 18 inches of the enclosure.
- Improper installation of cable glands, conduits or stopping plugs invalidates the Ex approval of this device.
- Make sure that the housing of the device is properly bonded to the Protective Earth (PE).

WARNING!
Cables and cable glands for at least 105 °C (221 °F) shall be used. When the ambient temperature is known to be always less than 50 °C (122 °F), cables and cable glands for at least 90 °C (194 °F) can be used.

5.2. Grounding

WARNING!
Make sure the housing of the device is properly connected to the ground reference! Make sure the electrical resistance of the ground connection is below the maximum prescribed by local requirements!

WARNING!
The instrument may not be opened when an explosion atmosphere may be present. Failure to do so may cause danger to persons or damage the equipment.

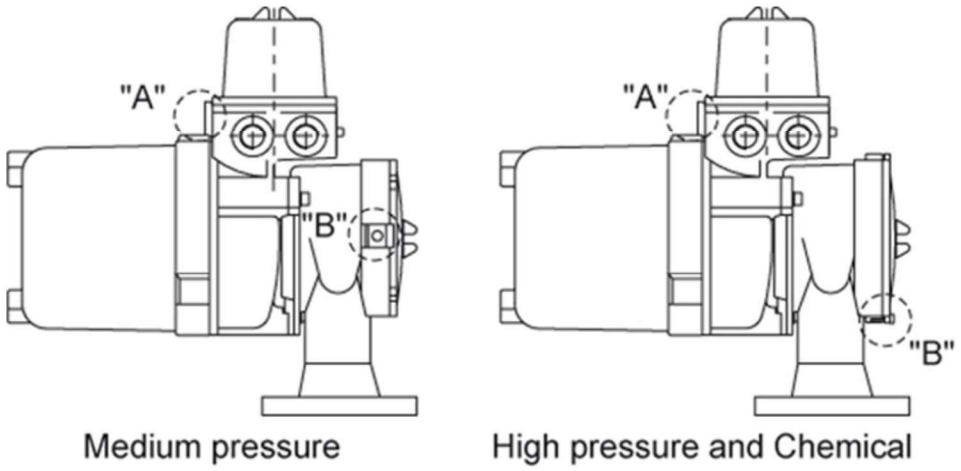


Figure 8 Optional Blocking Devices

CAUTION

CAUTION!
Before opening the electronic and terminal compartment cover, remove the optional blocking devices which locks the covers: "A": for electronic compartment cover and terminal compartment cover; "B": for drum compartment cover.

CAUTION

CAUTION!
Do not damage the thread of the covers and instrument and keep the thread free of dirt.

After opening, grease it lightly with anti-seize grease.

When closing, never tighten the covers before the threads are properly engaged. The covers should be turned counter-clockwise until the thread clicks in place, then turn clockwise until the covers are fully closed.

After closing the covers, do not forget to place the blocking devices.

5.3. **Safety**

5.3.1. General Relative Density

WARNING!
Make sure the power to the device is switched OFF, before you open the cover of the device.

CAUTION!
Do not make any additional holes in the housing.

WARNING!
Make sure that no explosive gas mixtures build up in the working area.

5.4. Installing the Cable Glands and Stopping Plugs

WARNING!
Only use Ex e or flameproof certified materials of an appropriate IP value.

CAUTION!
Improper installation of cable glands or stopping plugs will invalidate the Ex approval of the 954 SmartServo FlexLine.

5.4.1. Cable Glands

Use Ex e or Ex d 3/4" NPT cable glands (or where applicable equivalent conduit connections) with an appropriate IP value. See the type plate on the device.

NOTE:
Install the cable glands according to the instructions provided by the manufacturer.

5.4.2. Unused Cable Inlets

Seal unused cable inlets with approved ¾" NPT threaded stopping plugs.

5.5. Installing the Glands, Conduits and Stopping Plugs

CAUTION!
Improper installation of cable glands, conduits, or stopping plugs will invalidate the Ex approval of the 954 SmartServo FlexLine.

5.5.1. Conduits

Use explosion proof (Ex d) conduits with an appropriate IP value. See the type plate on the device.

WARNING!
If the 954 SmartServo FlexLine is installed in a hazardous area:
Metal conduits must be used, size 3/4".

Stopper boxes must be installed within 45 cm (18") of the device to seal the cabling in the conduit.

NOTE:
Install the conduits according to the instructions provided by the manufacturer.

5.5.2. Unused Cable Inlets

Seal unused cable inlets with approved ¾" NPT threaded stopping plugs.

5.6. **Electrical Connections**

CAUTION!
Cables must always comply with the defined cable specifications.

5.6.1. Grounding

The 954 SmartServo FlexLine housing must be properly grounded to the ground reference (generally the tank), according to local regulations. This is a safety grounding requirement.

WARNING!
When measuring the ground resistance, use a suitable instrument that is approved for use in hazardous areas.

WARNING!
Safety depends on proper grounding. Check the resistance of the ground connection directly after installation. The measured ground resistance must be below the maximum prescribed by local and/or national grounding requirements.

5.6.2. Connections

WARNING!
The intrinsically safe options have been certified for use in hazardous areas. Make sure that the certificate of approval is available on site and act in accordance with the instructions as given in the certificate.

WARNING!
Intrinsically safe wiring must be separated from all other wiring. The cable lay-out must be in accordance with local and/or national regulations.

NOTE:
Connect the armoring of the cable externally in the cable gland at both ends of the cable

The terminal compartment is located at the top of the device (see Figure 10) and it is divided into two zones:

- Blue terminals, for intrinsically safe connections, such as HART, VITO, RTD, MRT / MPT and HART SmartView.
- Grey terminals, for non-intrinsically safe connections.

The indices of the terminals are variable. They are specified in a label attached in front of the terminal row, as is schematically indicated in Figure 11.

5.6.2.1. *General Procedure*

Connect the wiring to the terminals with the numbers as shown in the tables in the following sections.

5.6.2.2. *954 SmartServo FlexLine Board Overview*

CAN-Servo, CAN-PSS, CAN-HART, and CAN-LCD boards are part of each 954 SmartServo FlexLine device. All remaining boards mentioned in this Installation Manual are optional (see Figure 9).

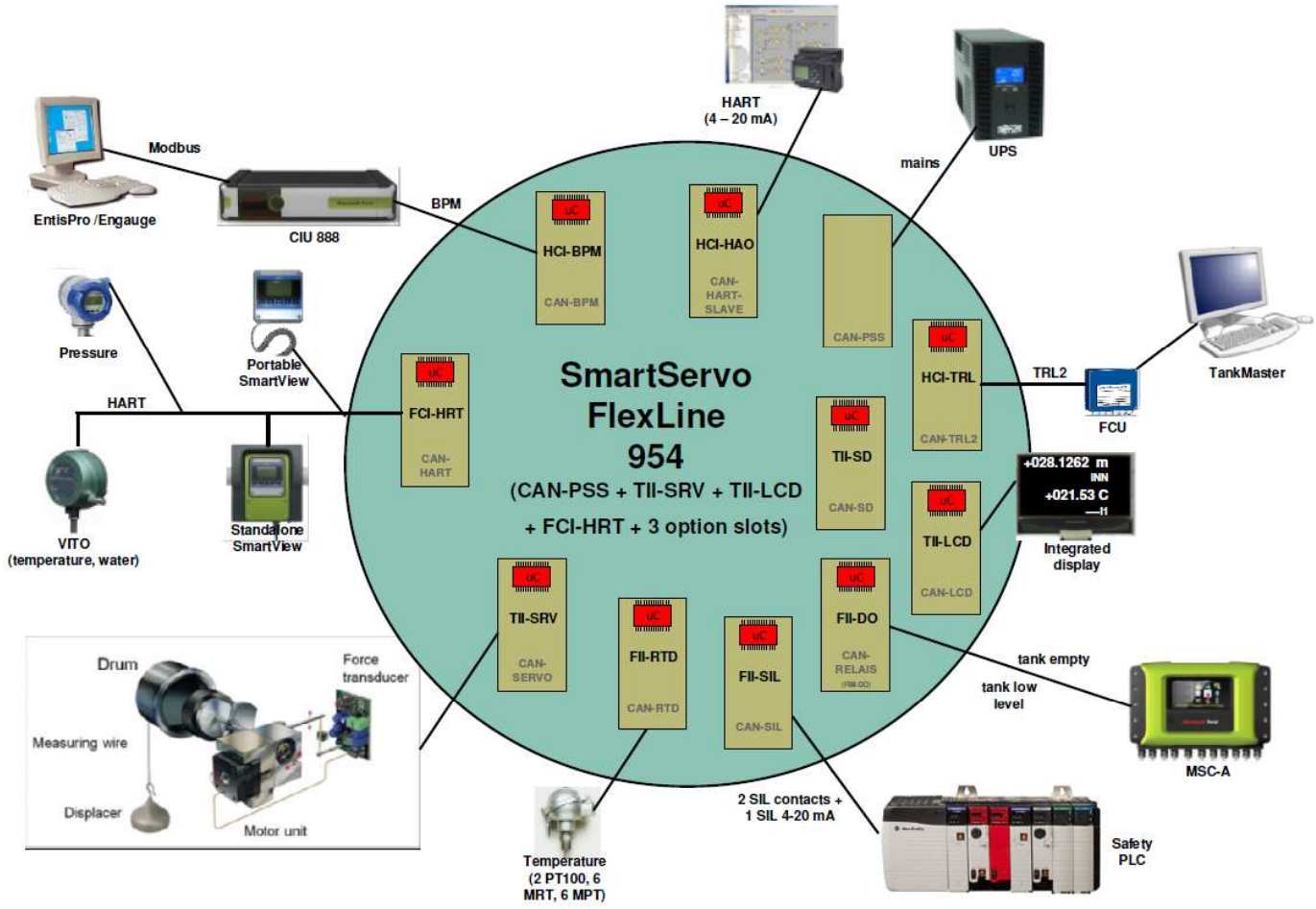


Figure 9 954 SmartServo FlexLine Board Overview

5.6.2.3. *Non-intrinsically Safe Connections*

The non-intrinsically safe connections are connected to the grey wiring terminal.

If local and or national regulations allow, the power supply, Enraf fieldbus, and hardware relay outputs may be combined into one, unshielded, cable.

A separate cable may also be used for each.

5.6.2.4. *Lay-out Terminal Compartment*

The terminal compartment on top of the 954 SmartServo FlexLine is divided into a non-intrinsically safe and an intrinsically safe part. Cable entries are ¾" NPT.

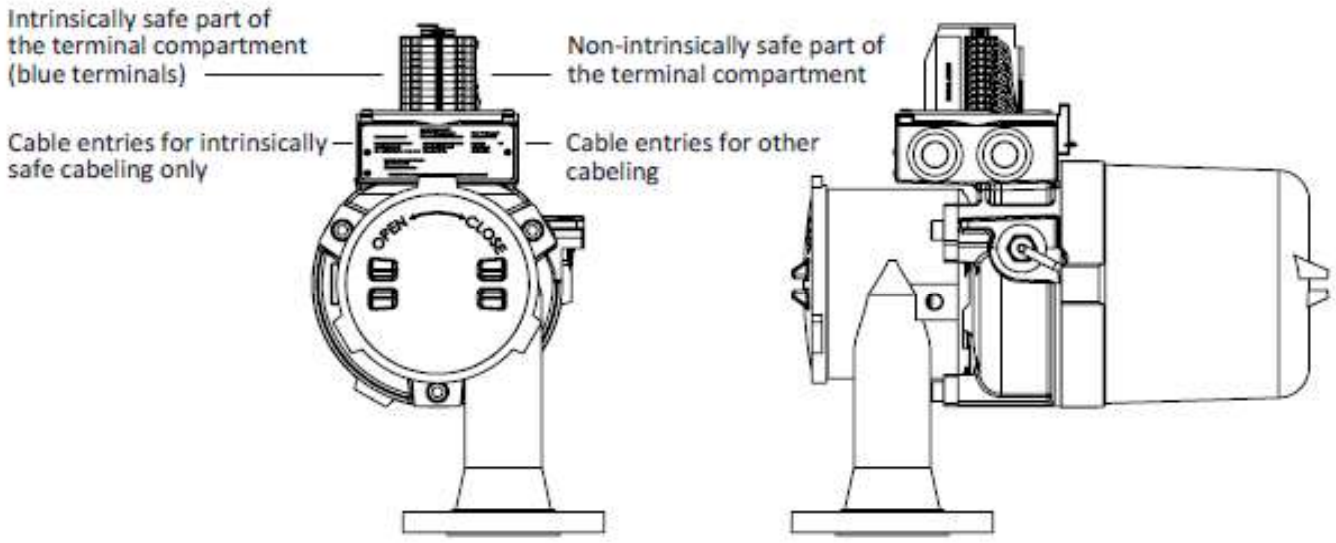


Figure 10 Intrinsically Safe and Non-Intrinsically Safe Cable Entries

The non-intrinsically safe cabling may only enter at the two right hand side cable entries (Figure 10).

WARNING!
The Instrument may not be opened when an explosive atmosphere may be present.

5.6.2.5. *Non-intrinsically Safe Cabling*

Mains cabling: Must be suitable for the 954 SmartServo FlexLine power rating and, moreover, approved for the use in hazardous areas.

Honeywell Enraf field bus lines may be interchanged. If local regulations allow, mains and Honeywell Enraf field bus lines may share one cable.

Mind the isolation voltage of the cores in the cable; refer to the International Standard IEC 61010-1.

NOTE:
If a quad cable is used and all four cores are twisted together, use two opposite cores for Honeywell Enraf field bus lines and the two others for mains.

Terminal information:

Solid / stranded	: 0.5…6 / 1.5…4
Flexible / stranded wire with end	: 0.5…4 / 0.5…2.5
Tightening torque range (clamping)	: 0.6…0.8 Nm (M 3)
Stripping length / Blade size	: 8 / 0.6 x 3.5 mm

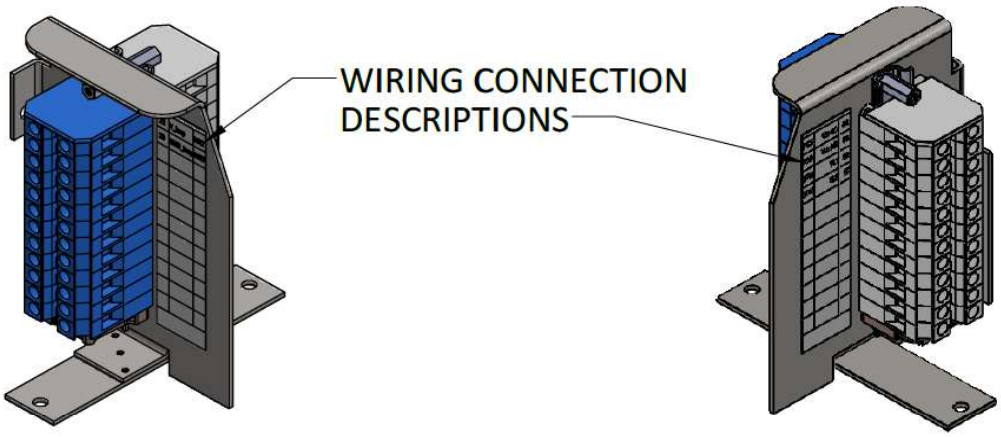


Figure 11 Wiring Connection Descriptions

5.6.2.6. *Power Supply (CAN-PSS)*

Connect the power supply to either:

- DC: 24 - 65 Volt
- AC: 65 - 240 Volt

NOTE:
The DC polarity is not critical.

NOTE:
Disconnection from the supply source needs to be performed externally with an easy accessible and clearly marked switch or circuit breaker as disconnecting device and shall disconnect all current carrying conductors.

5.6.2.7. *Cable Specifications*

Cable specifications	
Type	Suitable for the 954 SmartServo FlexLine power rating, and approved for use in hazardous areas

Label	**Parameters**
00. Vin-a/L	24-65 Vdc -15/+10% 65-240 Vac -15/+10% 50/60 Hz ± 10% Automatic selection
01. Vin-b/N	

5.6.2.8. *Enraf Fieldbus (Bi Phase Mark) (CAN-BPM)*

Cable specifications	
Type	Twisted pair; R_{max} = 200 Ohm /line, C_{max} = 1 µF.
Maximum length	10 km

Label	**Parameters**
06.or 08 TL1	1200/2400/4800 bps Selection by software
07.or 09 TL2	

A maximum of 10 devices can be connected to the Enraf field bus line.

For short distances up to 20 devices can be connected. This number will be specific to every situation.

5.6.2.9. *Emerson TRL/2 Field Bus (CAN-TRL2)*

Cable specifications	
Type	18 AWG (minimum) with shielded twisted pair, with max 8 multi drop Gauge connections
Maximum length	4 km

Label	**Parameters**
06. or 08 TL1	4800 bps
07. or 09 TL2	

5.6.2.10. *Alarm Relay Outputs (CAN-RELAIS)*

The hardware relay outputs can be used as an alarm signal or to operate a remote device.

The signals corresponding with the terminal labels are programmed during commissioning.

Cable specifications	
Type	Approved for use in hazardous areas and suitable for the specified power rating.

Label	**Parameters**
14. Ry1_a	Vmax = 125 Vac, Imax = 0.5 A, via double isolated transformer
15. Ry1_b	Vmax = 110 Vdc, Imax = 0.3 A, Pmax = 30 W NO/NC by factory jumper
16. Ry2_a	Vmax = 125 Vac, Imax = 0.5 A, via double isolated transformer
17. Ry2_b	Vmax = 110 Vdc, Imax = 0.3 A, Pmax = 30 W NO/NC by factory jumper (default = NO)

Label	Parameters
18. Ry3_a 19. Ry3_b	Vmax = 150 Vac, Imax = 3 A, Vmax = 40 Vdc, Imax = 3 A, Pmax = 450 W NO/NC by factory jumper
20. Ry4_a 21. Ry4_b	Vmax = 150 Vac, Imax = 3 A, Vmax = 40 Vdc, Imax = 3 A, Pmax = 450 W NO/NC by factory jumper

5.6.2.11. *SIL Overfill and Underfill Protection (CAN-SIL)*

Label	Parameters
50. AO-PAS + 51. AO-COM 52. AO-ACT -	Iin / Iout = 1 ….24 mA Vin / Vout = 10…24.5 V

If the sensor powers the loop connect sensor between terminals 50 AO-Pas + and 51 AO-ACT –

If the Servo powers the loop connect sensor between terminals 51 AO-COM + and 52 AO-ACT –

Label	Parameters
54. DO1_a 55. DO1_b	Vmax = 250 Vac, Imax = 2 A Vmax = 40 Vdc, Imax = 2 A Pmax = 500 W
56. DO2_a 57. DO2_b	Vmax = 250 Vac, Imax = 2 A Vmax = 40 Vdc, Imax = 2 A Pmax = 500 W

5.6.2.12. *HART and Analog Output (CAN-HART-SLAVE)*

Cable specifications	
Type	Shielded twisted pair
Maximum length	1200 meter

Label	Parameters
46 or 48 4-20 mA +	Iloop 0 to 25 mA
47 or 49 4-20 mA -	Vmax 55 Volts

5.6.2.13. *VITO Temperature, HART Slave and SmartView (CAN-HART)*

NOTE:
Intrinsically Safe Connections

The intrinsically safe connections are connected to the blue wiring terminals.

VITO (for temperature and water bottom measurement)

Cable specifications	
Type	Twisted pair, shielded. R_{max} = 25 Ω / line
Maximum length	1000 meter

Label	Parameters	
22. V_Loop	[Ex ia] IIB	*The I/O shall not be accessible or shall be isolated in the end use.*
23. GND_Loop	Uo = 23.1 V	*Ensure the end user cannot touch these wires when energized.*
	Uo = 23.1 V	
	Io = 124 mA	
	Po = 0.6 W	
	Co = 1.0 µF	

HART Transmitters

Cable specifications	
Type	Twisted pair, shielded. R_{max} = 25 Ω / line
Maximum length	1000 meter

Label	Parameters
24. V_Loop	[Ex ia] IIB *The I/O shall not be accessible or shall be isolated in the end use.*
25. GND_Loop	Uo = 23.1 V *Ensure the end user cannot touch these wires when energized.* Io = 124 mA Po = 0.6 W Co = 1.0 µF Lo = 9 mH

Stand-alone HART SmartView Display

Cable specifications	
Type	Twisted pair, shielded. R_{max} = 25 Ω / line
Maximum length	1000 meter

Refer to HART Communication Foundation document number HCF_SPEC-54 (FSK Physical Layer Specification) for detailed length calculations.

Connection Table

Label 954 SmartServo FlexLine	Parameters 954 SmartServo FlexLine	Label HART SmartView	Parameters HART SmartView
24. V_loop	[ia Ga] IIB T6 Ga/ Gb	2. Loop +	[Ex ia] IIB T4 Gb
25. GND_Loop	Uo = 23.1 V	1. Loop -	Ui = 30 V
	Io = 124 mA		Ii = 200 mA
	Po = 0.6 W		Pi = 0.7 W
	Co = 1.0 µF		Ci = 10 nF
	Lo = 9 mH		Li = 16 µH

The I/O shall not be accessible or shall be isolated in the end use. Ensure the end user cannot touch these wires when energized.

5.6.2.14. *Topology*

Terminals for HART and VITO are combined. A maximum of 4 HART devices, or 2 HART devices if VITO is present, can be connected to the HART connection.

CAUTION

CAUTION!
Before connecting the HART devices:

Make sure the sum of the start-up currents fits the parameters.

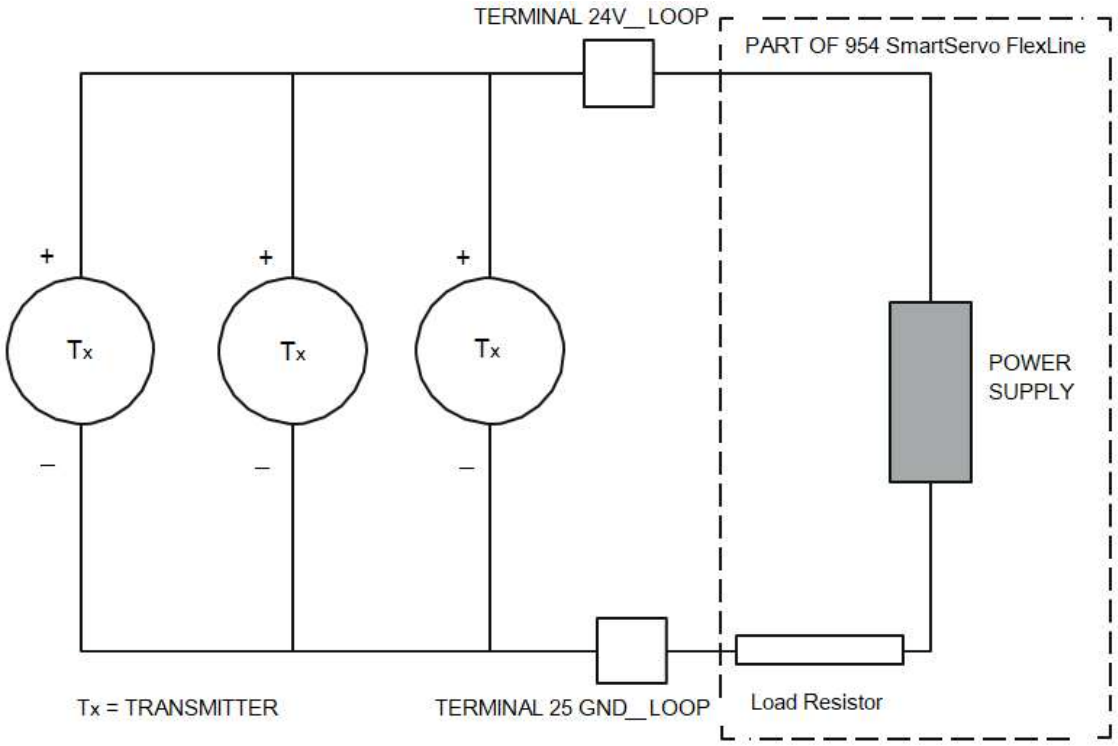
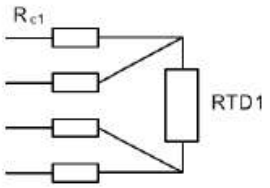
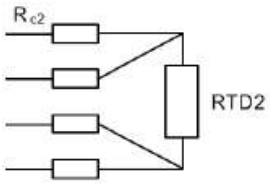


Figure 12 Topology

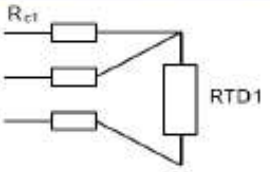
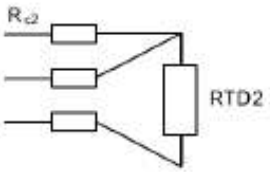
5.6.2.15. *RTD, MRT, MPT Temperature Measurement (CAN-RTD)*

Cable specifications	
Type	Shielded. R_{max} = 100 Ω / line
Maximum length	150 meter

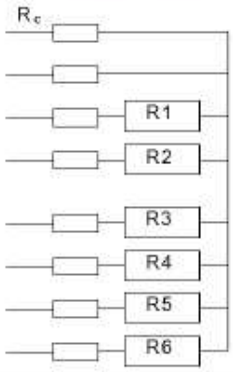
RTD, 4-Wire Connection

Label	Connections diagram	Parameters
30. RTD1_S-		[Ex ia] IIB/IIC U_o = 8.61 V I_o = 58 mA P_o = 0.13 W C_o = 1.0 µF L_o = 10.5 mH *The I/O shall not be accessible or shall be isolated in the end use. Ensure the end user cannot touch these wires when energized*
31. RTD1_com		
32. RTD1_pos		
33. RTD1_S+		
34. RTD2_S-		
35. RTD2_com		
36. RTD2_pos		
37. RTD2_S+		

RTD, 3-Wire Connection

Label	Connections diagram	Parameters
30. RTD1_S-		[Ex ia] IIB/IIC U_o = 8.61 V I_o = 58 mA P_o = 0.13 W C_o = 1.0 µF L_o = 10.5 mH *The I/O shall not be accessible or shall be isolated in the end use. Ensure the end user cannot touch these wires when energized*
31. RTD1_com		
32. RTD1_pos		
34. RTD2_S-		
35. RTD2_com		
36. RTD2_pos		

MPT – MRT

Label	Connections diagram	Parameters
38. S-		[Ex ia] IIB/IIC U_o = 8.61 V I_o = 58 mA P_o = 0.13 W C_o = 1.0 µF L_o = 10.5 mH *The I/O shall not be accessible or shall be isolated in the end use. Ensure the end user cannot touch these wires when energized*
39. com		
40. R1		
41. R2		
42. R3		
43. R4		
44. R5		
45. R6		

5.7. Finishing Installation

CAUTION!
Make sure the separation between intrinsic and non intrinsic cabling is sufficient and complies with any local and/or national regulations.

5.7.1. Assembling the Terminal Block and Board Compartment's Lids

WARNING!
Make sure the surface of the O-ring grooves of the housing are clean and the O-rings are not damaged before assembling the lids to the 954 SmartServo FlexLine housing.

Make sure that the both lids (used for terminal block and board compartments) do not squeeze any cables during the assembly.

NOTE:
If existing installations have terminals 22 (V_Loop) and 23 (GND_Loop), VITO must be connected between them.

5.8. External Fusing

The 954 SmartServo FlexLine external fuses must be installed in the mains supply cable to each 954 SmartServo FlexLine.

mains voltage	fuse value (in accordance with IEC 127-2-3)
220 Vac or 230 Vac	315 mA slow
110 Vac or 130 Vac	630 mA slow
65 Vac	1 A slow

5.9. Cable Glands / Conduit

Explosion-proof (Ex d) or increased safe (Ex e) cable glands must be used, depending on local requirements. Refer to the Ex-marking on the identification label of the 954 SmartServo FlexLine to determine which type of cable glands is required.

NOTE:
Mount the glands according to the supplier's instructions.

Conduit:

If the 954 SmartServo FlexLine is installed in a hazardous area, threaded rigid metal conduit or threaded steel intermediate metal conduit shall be used.

NOTE:
If the 954 SmartServo FlexLine is installed in a hazardous area, Ex d certified conduit seals must be applied directly at the wall of the 954 SmartServo FlexLine to seal the cabling in the conduit.

Depending on the wiring configuration, one to four ¾" NPT threaded cable glands (or rigid conduits) may be required with the 954 SmartServo FlexLine.

NOTE:
Seal the unused cable inlets with an approved ¾" NPT threaded stopping plug.

WARNING!
Improper installation of cable glands, conduit or stopping plugs will invalidate the Ex approval of your 954 SmartServo FlexLine.

5.10. Grounding

The 954 SmartServo FlexLine housing should be properly grounded to the ground reference (generally the tank).

This is a safety grounding requirement. Grounding can be performed by copper strips across the flanges (refer to section Grounding at mechanical installation), or by a ground wire.

With last mentioned method, use one of the external ground terminals of the 954 SmartServo FlexLine.

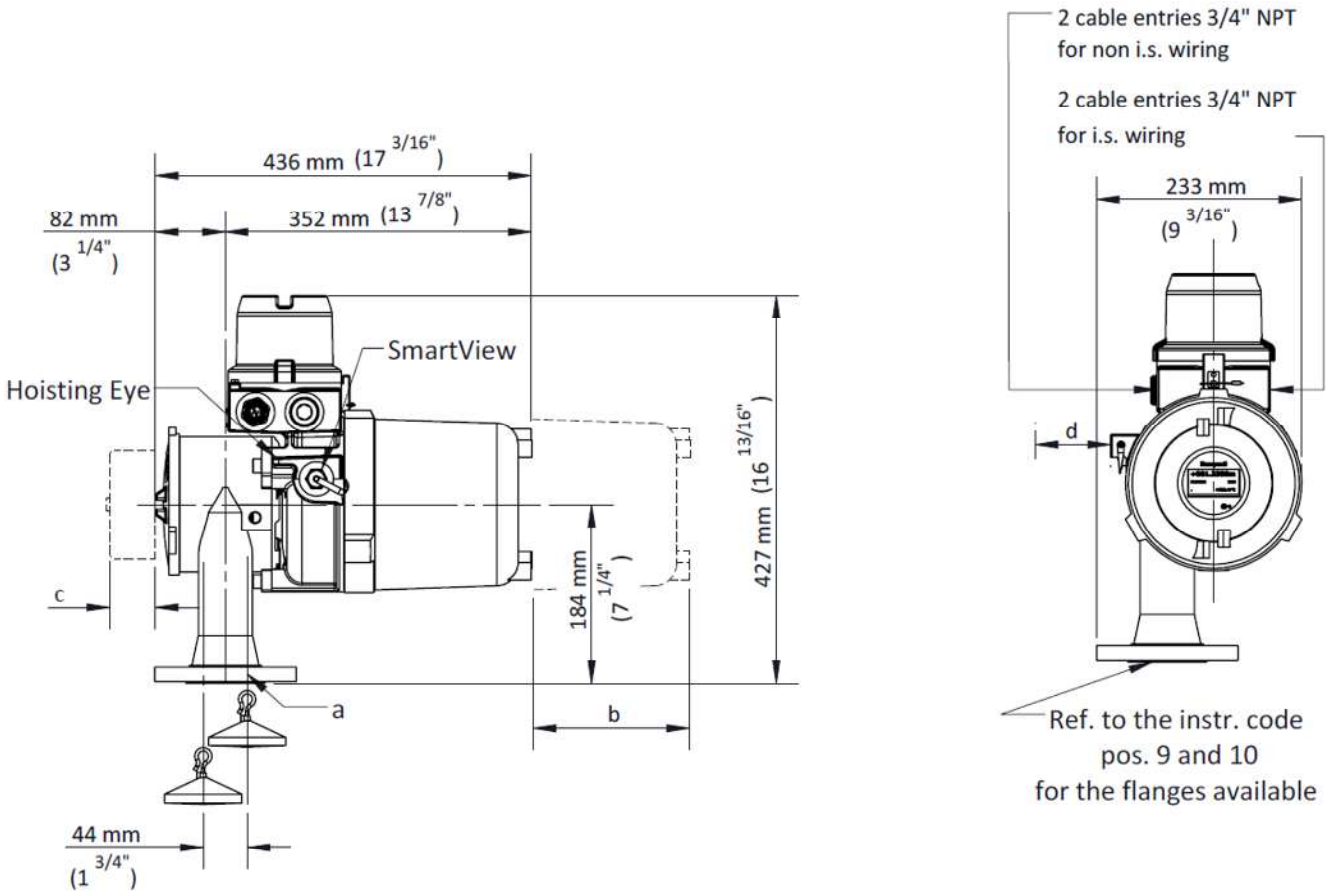
NOTE:
Grounding shall be performed in accordance with local regulations.

CAUTION!
Safety depends on proper grounding. Check the resistance of the ground connection directly after installation. The measured ground resistance shall be below the maximum prescribed by local grounding requirements.

WARNING!
When measuring the ground resistance, use a suitable explosion-proof tester.

Appendix A

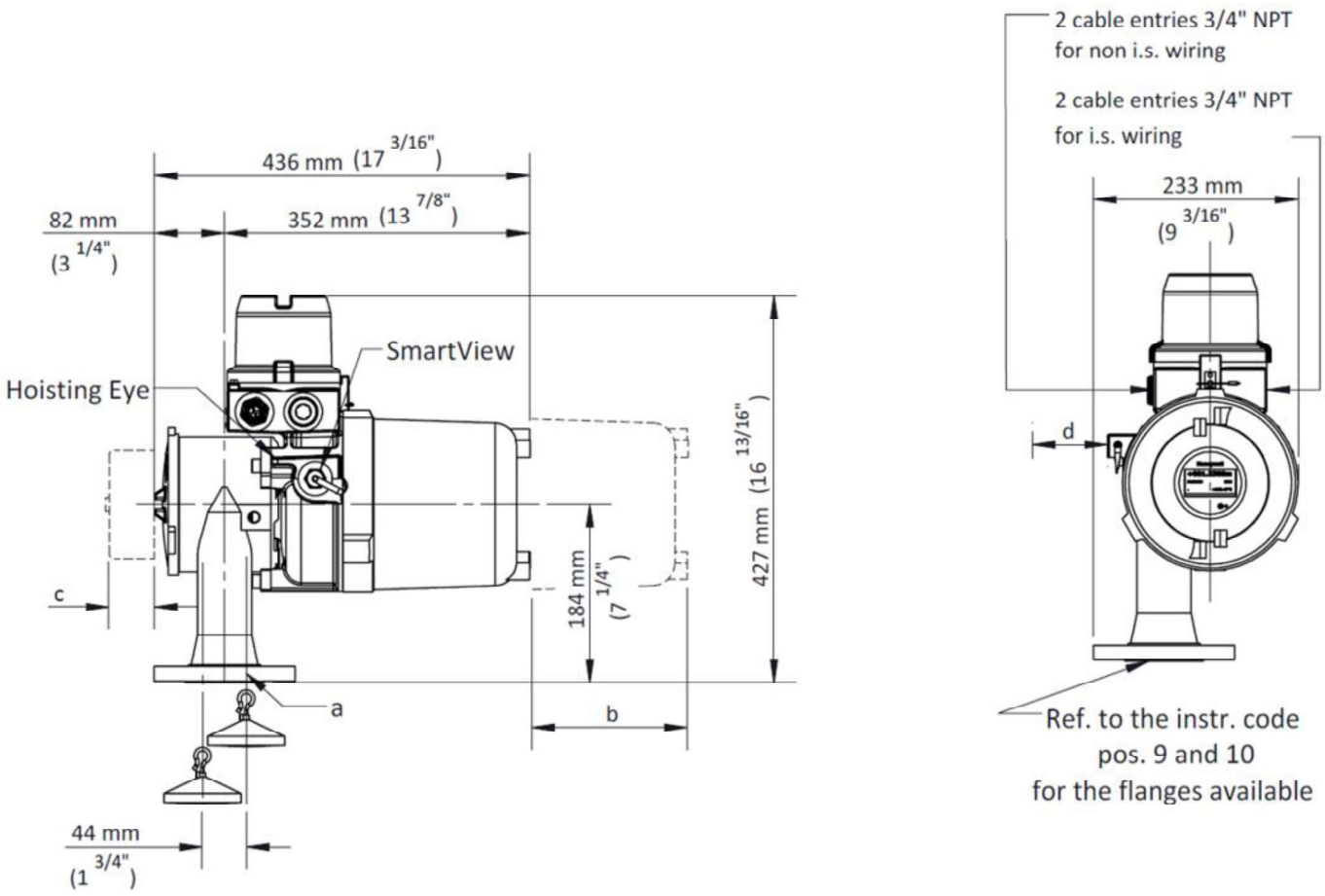
Dimensions 954 SmartServo FlexLine (Medium Pressure and Chemical Version)



a. Position of measuring wire with displacer in top position
b. 200 mm (7 7/8") (space needed to remove cover)
c. 65 mm (2 9/16") (space needed to remove measuring drum)
d. 100 mm (4") (free space for SmartView Connection)

Appendix A (Continuation)

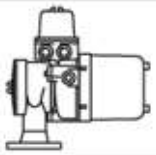
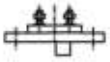
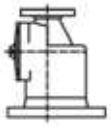
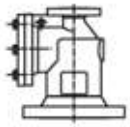
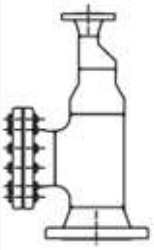
Dimensions 954 SmartServo FlexLine (High Pressure Version)



a. Position of measuring wire with displacer in top position
b. 200 mm (7 7/8") (space needed to remove cover)
c. 65 mm (2 9/16") (space needed to remove measuring drum)
d. 100 mm (4") (free space for SmartView Connection)

Appendix B

Available Adapters & Calibration Chambers

Orientation	Specifications		
	Orientation of adapters, reducers and calibration chambers with respect to the 854 ATG as drawn. Asymmetrical adapters must be mounted in the right way with respect to the 854 gauge in order to prevent malfunctioning of the gauge. For symmetrical adapters the orientation is insignificant.		
	**Flange adapter** for medium pressure		
	2" to 6", 150 lbs, ff (aluminium, 3.2371)	Height: 48 mm (1 7/8")	Part no.: 0815.092
	NW50-ND6 to NW150-ND16, ff (aluminium, 3.2371)	Height: 48 mm (1 7/8")	Part no.: 0815.093
	2" to 6", 150 lbs, ff (AISI 316, 1.4401)	Height: 48 mm (1 7/8")	Part no.: 0815.095
	**Calibration adapter** for medium pressure 0.6 MPa (88 psi)		
	2" to 6", 150 lbs (aluminium, 3.2371)	Height: 307 mm (12 1/16")	Part no.: 0815.091
	2" to 8", 150 lbs (aluminium, 3.2371)	Height: 307 mm (12 1/16")	Part no.: 0815.096
	NW50-ND6 to NW150-ND16 (aluminium, 3.2371)	Height: 307 mm (12 1/16")	Part no.: 0815.094
	2" to 6", 150 lbs (stainless st. ASTM A 351 CF8M, 1.4408)	Height: 288 mm (11 3/8")	Part no.: 0815.086
	**Calibration adapter** for high pressure 4 MPa (590 psi)		
	2" to 6", 300 lbs (Stainless st. ASTM A351 CF8M, 1,4408)	Height: 344 mm (13 9/16")	Part no.: 0815.534
	NW50-ND40 to NW150-ND40 (Stainless st. ASTM A351 CF8M, 1,4408)	Height: 344 mm (13 9/16")	Part no.: 0815.532
	**Adapter** for medium pressure		
	2" to 4", 150 lbs	Height: 241 mm (9 1/2")	
	for high pressure		
	2" to 4", 300 lbs	Height: 257 mm (10 1/8")	
	**Adapter** for medium pressure		
	2" to 6", 150 lbs	Height: 392 mm (15 7/16")	
	2" to 8", 150 lbs	Height: 417 mm (16 7/16")	
	for high pressure		
	2" to 6", 300 lbs	Height: 410 mm (16 1/8")	
	2" to 8", 300 lbs	Height: 435 mm (17 1/8")	
	**Adapter** for medium pressure		
	2" to 4" with 4" blind flange, 150 lbs	Height: 451 mm (17 3/4")	
	2" to 6" with 4" blind flange, 150 lbs	Height: 679 mm (26 3/4")	
	2" to 8" with 6" blind flange, 150 lbs	Height: 775 mm (30 1/2")	
	for high pressure		
	2" to 4" with 4" blind flange, 300 lbs	Height: 467 mm (18 3/8")	
	2" to 6" with 4" blind flange, 300 lbs	Height: 695 mm (27 3/8")	
	2" to 8" with 6" blind flange, 300 lbs	Height: 791 mm (31 1/8")	
	* Mat.: Flanges ASTM A 105, Grade N Body : ASTM A 105, Grade N		

For service-related questions, contact:

Technical Assistance Centre
Phone:
+1 800 423 9883 or +1 215 641 3610
E-mail:
HFS-TAC-SUPPORT@honeywell.com

For more information
To learn more about SmartLine Transmitters,
visit **www.honeywellprocess.com**
Or contact your Honeywell Account Manager

Process Solutions
Honeywell
1250 W Sam Houston Pkwy S
Houston, USA, TX 77042

Honeywell Control Systems Ltd
Honeywell House, Skimped Hill Lane
Bracknell, England, RG12 1EB

Shanghai City Centre, 100 Jungi Road
Shanghai, China 20061

www.honeywellprocess.com

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Honeywell

Safety Manual
954 SmartServo FlexLine

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For service related questions contact:

Head Office - Delft, The Netherlands

Honeywell Enraf
Delftechpark 39, 2628 XJ Delft
PO Box 812, 2600 AV Delft
The Netherlands

Tel.: +31 (0)15 2701 100
Fax: +31 (0)15 2701 111

E-mail: HFS-TAC-Support@Honeywell.com
Website: www.honeywellprocess.com

About this manual

This manual describes the Functional Safety of the 954 SmartServo FlexLine.

For installing, wiring, configuring, starting up, operating, maintaining and calibrating refer to the 954 SmartServo FlexLine Installation guide listed below in References.

For Installation Instructions and Procedures refer to the 954 Installation Manual listed below in References.

Introduction

The 954 SmartServo FlexLine is an automatic tank gauge measuring the surface or interface level of crude oil or derived products stored in a bulk storage tank. Typically, those storage tanks are available on terminals, production plants and refineries in the petro chemical, oil and gas industry. The environment on those sites is typically explosion hazardous.

The end user will typically use the 954 SmartServo FlexLine together with a Terminal Inventory System for custody transfer operations, so Weights and Measures legislation is applicable.

The 954 SmartServo FlexLine is based on the modular FlexConn board architecture. Every FlexConn board supported in this device is described in detail.

Revision History

954 Safety Manual (This document)

4417342	00	4th December 2018 (1st Release)
4417342	01	10th December 2018 (Updated the document)
4417342	02	04th March 2019 (Updated the document based on Service Manual)

References

The following list identifies publications that may contain information relevant to the information in this document.

4417340	1	954 Service Manual
4417341	1	954 Installation Manual

Contents

Figures

Tables

1. CHAPTER 1: Introduction

1.1 About this Manual

1.1.1 Purpose

The Safety Manual provides information about the 954 SmartServo FlexLine level gauge that is relevant for integration of this servo-based level gauge into a Safety Instrumented System (SIS). This manual is aimed at technical personnel responsible for such integration.

1.1.2 Content

Chapter Title	Contents Description
Introduction	This chapter.
Functions, Architecture and Compliance	Specification of the Safety Instrumented Functions (SIF) that are applied and the architecture(s) these SIFs need to operate. Furthermore, relevant certification and compliance information is given.
Implementation	Description of - or reference to - details how to achieve and implement the applicable SIFs.
Maintenance Requirements	Description of - or reference to - details how to maintain the required Safety Integrity Levels of the implemented SIFs.

Table 1 Structure of the Safety Manual

1.1.3 Related Documents

- IEC 61508 (2010)
- IEC 61511 (2017)
- Installation Manual 954 SmartServo FlexLine; Part No.: 4417341
- Service Manual 954 SmartServo FlexLine; Part No.: 4417340

1.2 Basic Skills and Knowledge

Before you start to work on the 954 SmartServo FlexLine level gauge it is assumed that you are certified to do work on safety related systems and devices (e.g. certified Enraf Service Specialist), and that you have appropriate knowledge of:

- The concepts and functioning of the 954 SmartServo FlexLine level gauge,
- The applicable process and equipment under control within the SIS,
- This Safety Manual,
- Site procedures,
- Applicable safety standards (e.g. IEC 61508 and IEC 61511).

1.3 Safety Standards

1.3.1 Safety Instrumented Systems, Functions and Integrity Levels

Processes and Equipment Under Control (PUC/EUC) in the process industry require a high level of safety. Safety Instrumented Systems (SIS) are used to perform Safety Instrumented Functions (SIF). Instrumentation that is used for SIFs, must meet minimum standards and performance levels. Standards like IEC 61508 and IEC 61511 have been developed for this purpose. One of the performance criteria that these standards apply is the Safety Integrity Level (SIL).

IEC 61508 details the design requirements for achieving the required SIL. The safety integrity requirements for each individual safety function may differ. The safety function and SIL requirements are derived from hazard analyses and risk assessments. The higher the level of adapted safety integrity, the lower the likelihood of dangerous failure of the SIS. These standards also address the safety-related sensors and final elements regardless of the technology used.

The 954 SmartServo FlexLine level gauge can be used for a specific SIF that demands SIL 1 or SIL 2 (Hardware Fault Tolerance (HFT) = 0). If used in a redundant arrangement, the 954 SmartServo FlexLine level gauge can be applied in safety loops that require SIL 3 (HFT = 1).

1.3.2 What Standard to Use

IEC 61508 has been developed as a generic standard. A framework of standards, incl. IEC 61511, for specific industry sectors were based on this one. The information in the Table below is meant as a guideline.

Standard	Typical Application within the Process Industry
IEC 61508 Functional safety of electrical / electronic / programmable electronic (E/E/PE) safety-related systems	If you are a manufacturer, it is strongly recommended that you apply the IEC 61508. This generic standard is intended to provide guidance on how to develop E/E/PE safety-related devices as used in Safety Instrumented Systems (SIS). The IEC 61508 serves as a basis for the development of sector standards (e.g. for the machinery sector, the process sector, the nuclear sector, etc.). It can serve as stand-alone standard for those sectors where a sector specific standard does not exist.
IEC 61511 Functional safety - Safety instrumented systems for the process industry sector	If you are an owner/user, it is strongly recommended that you apply the IEC 61511. This standard addresses the application of SISs for the process industries. It requires a process hazard and risk assessment to be carried out, to enable the specification for SISs to be derived. In this standard, a SIS includes all components and subsystems necessary to carry out the safety instrumented function from sensor(s) to final element(s). The standard is intended to lead to a high level of consistency in underlying principles, terminology and information within the process industries. This should have both safety and economic benefits.

Table 2 Functional Safety Standards

1.4 Contact

Head Office - Delft, The Netherlands
Honeywell Enraf
Delftechpark 39, 2628 XJ Delft
PO Box 812, 2600 AV Delft
The Netherlands

Tel.: +31 (0)15 2701 100
Fax: +31 (0)15 2701 111
E-mail: enraf.helpdesk@honeywell.com
Website: http://www.honeywell.com/ps

2. CHAPTER 2: Functions, Architecture and Compliance

2.1 Safety Functions Description

Beside its standard functions the 954 SmartServo FlexLine level gauge can also be used for a Safety Instrumented Function (SIF) for storage tanks e.g. in the oil and gas industry.

The 954 SmartServo FlexLine is suitable for use in a SIS up to SIL 2. Under consideration of the minimum required hardware fault tolerance HFT=1 the device may be used in a redundant structure up to SIL 3.

The 954 SmartServo FlexLine is an automatic tank gauge measuring the surface or interface level of crude oil or derived products stored in a bulk storage tank. Typically, those storage tanks are available on terminals, production plants and refineries in the petro chemical, oil and gas industry. The environment on those sites is typically explosion hazardous. For that reason, the 954 SmartServo FlexLine is ATEX, IECEx, FM and CSA certified.

The end user will typically use the 954 SmartServo FlexLine together with a Terminal Inventory System for custody transfer operations, so Weights and Measures legislation is applicable. For that reason, the 954 SmartServo FlexLine will be OIML R85 and WELMEC 7.2 certified.

Overfill of a storage tank can cause damage to the environment or vapor emission with a potential occurrence of an explosion.

Underfill of a storage tank can cause dry run of a pump with a potential occurrence of a fire in the pump.

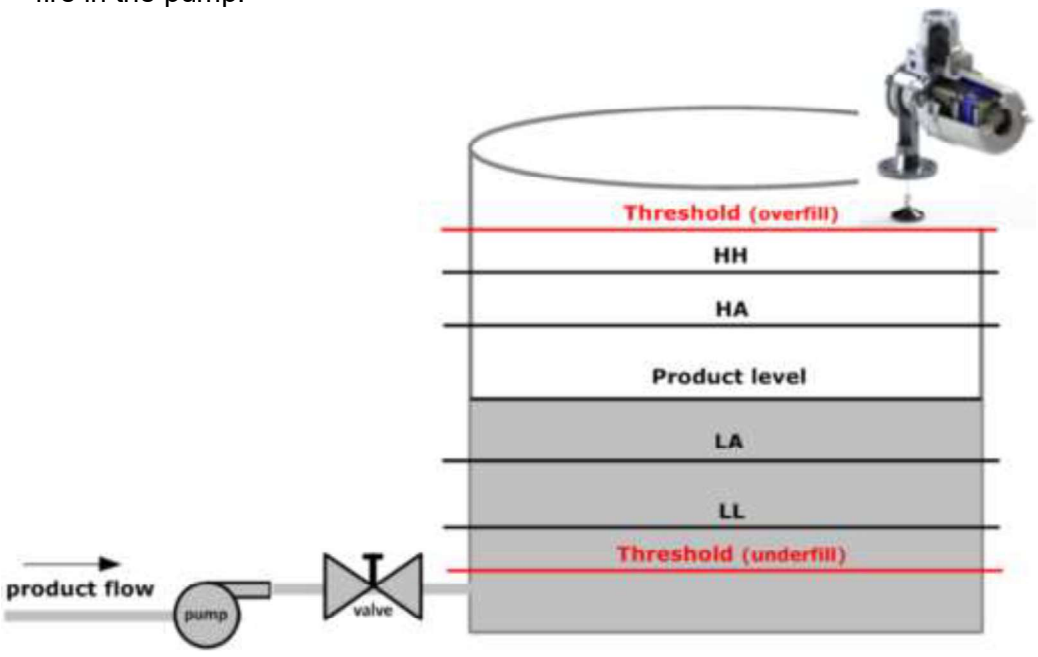


Figure 1 Overfill and Underfill Protection

Hazard and Risk Analysis

The consequences and likelihood of a potential overfill or underfill of a storage tank strongly depends on the customer application conditions and the environmental circumstances which cannot be taken into account from a vendor perspective.

It also depends on the independent layers of protection that are in addition also available like:

- Fire and gas detection systems
- Firefighting systems
- Plant emergency response provisions
- Other risk reduction systems like:
    - Relief valves
    - Mechanical overfill switches
    - Diking around the storage tanks
    - Draining system in tank pit

For that reason, the storage tank owners shall perform a HAZOP study to identify the required SIL for their safety functions.

2.2 Architecture

The 954 SmartServo FlexLine consists of a modular, multi board, multi CPU architecture. This architecture is called “FlexConn Architecture”.

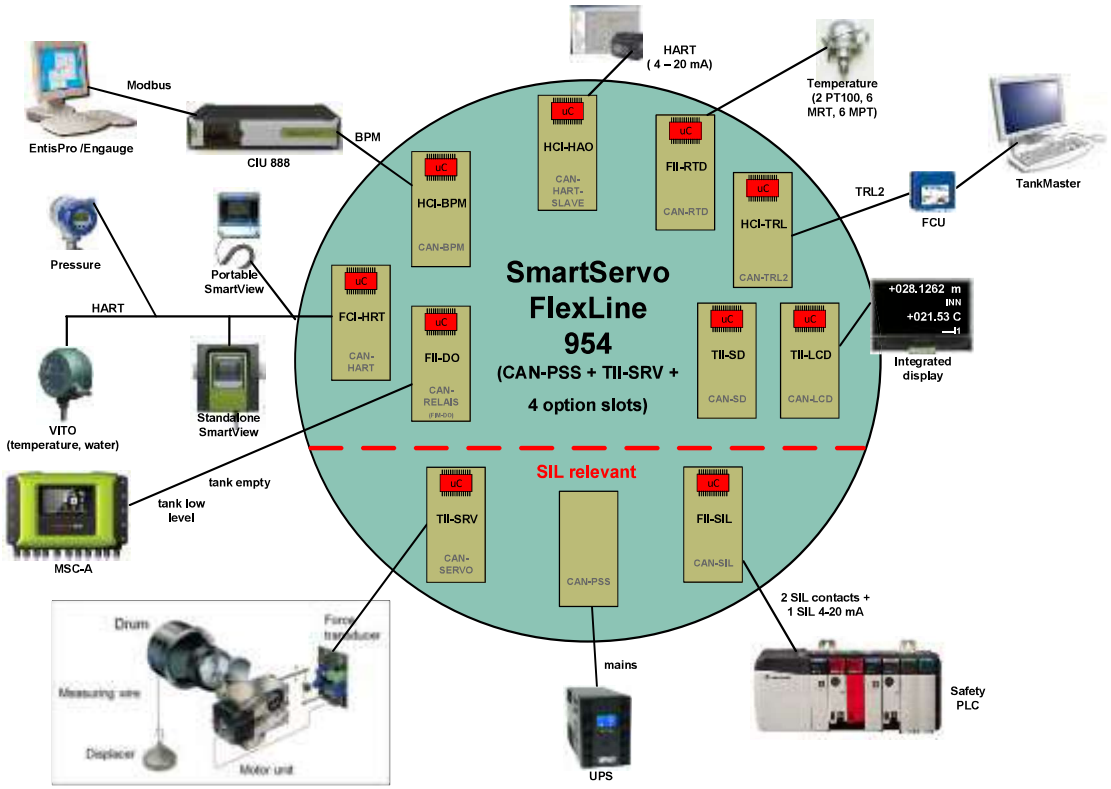


Figure 2 954 SmartServo FlexLine Architecture

The SIL relevant parts are:

- Mechanical Measuring System
- CAN-PSS - Power supply board
- CAN-SERVO (TII-SRV) - Sensor board
- CAN-SIL (FII-SIL) – Logic solver board

2.3 Compliance

Organization	Relevant details
IEC	The 954 SmartServo FlexLine level gauge is considered to be a Type B system in the meaning of IEC 61508. If implemented and maintained correctly, the safety parameters for the "overfill protection" and/or "underfill protection" are in the range of SIL 2.
TÜVRheinland CERTIFIED	Details of the assessment and certification by TÜV Rheinland are recorded in: Report No.: 968/FSP 1489.01/19 Certificate No.: 968/FSP 1489.01/19

Table 3 Certificate References

2.4 Safety-Related Data

The Table below specifies the applicable data (for Overfill) relating to IEC 61508:

Entity / parameter	Value Overfill	Remarks
Safety Integrity Level	SIL 2 Systematic safety integrity SIL 3	As single channel safety related subsystem. With a structure establishing a hardware fault tolerance of 1 the device is usable in SIL 3 applications.
Classification of the Device	Type B	
Mode of Operation	Low demand mode High demand mode Continuous mode	Acc. to IEC 61508-4, 3.5.16 and Acc. to IEC 61511-1, 3.2.43,2
Hardware Fault Tolerance	HFT 0 SIL2 HFT 1 SIL3	
Mean Time to Repair	MTTR 8 h	
Safe Failure Fraction	SFF 99.14%	
Diagnostic Coverage	DC 98 %	
Probability of Dangerous Failure on Demand	PFD_{avg} $10.76*10^{-04}$ For T1 is 1 year	For the calculation of PFDavg an assumed test interval of Ti = 1 year has been assumed *1
Probability of Dangerous Failure on Demand	PFD_{avg} $21.51*10^{-04}$ For T1 is 2 years	
Probability of Failure per Hour	PFH $2.4558*10^{-07}$ 1/h	
MTBF Dangerous Failures	$6.86*10^{+06}$ h	See note *3
Proof Test Interval	4 years	Recommended. Refer to Figure 3 for other options
Diagnostic Test Interval	1 Minute	For Electronics and Firmware. For Mechanics the diagnostic test interval is determined by the Servo Auto test setting. This can be configured to run between 1 minute and 28 Days. Default value is 1 hour.

Entity / parameter	Value Overfill	Remarks
Fault Reaction Time	1 minute	

*1) If other proof test interval shall be used, the diagram (Figure 3) shows how the PFD_{avg} is related to Ti.

*2) The SFF takes into account the failure detection provided by all relevant mechanical, electronics and software components of the device.

*3) MTBF is the predicted elapsed time between failures of a system in operation in accordance to the MIL HDBK 217 standard. This standard takes into account the failures of relevant electronics.

Table 4 Safety-Related Data Overfill

The Table below specifies the applicable data (for Underfill) relating to IEC 61508:

Entity / parameter	Value Underfill	Remarks
Safety Integrity Level	SIL 2 Systematic safety integrity SIL 3	As single channel safety related subsystem. With a structure establishing a hardware fault tolerance of 1 the device is usable in SIL 3 applications.
Classification of the Device	Type B	
Mode of Operation	Low demand mode High demand mode Continuous mode	Acc. to IEC 61508-4, 3.5.16 and Acc. to IEC 61511-1, 3.2.43,2
Hardware Fault Tolerance	HFT 0 SIL2 HFT 1 SIL3	
Mean Time to Repair	MTTR 8 h	
Safe Failure Fraction	SFF 98.4 %	
Diagnostic Coverage	DC 97 %	
Probability of Dangerous Failure on Demand	PFD_{avg} $20.23*10^{-04}$ For T1 is 1 year	For the calculation of PFDavg an assumed test interval of Ti = 1 year has been assumed *1
Probability of Dangerous Failure on Demand	PFD_{avg} $40.45*10^{-04}$ For T1 is 1 year	
Probability of Failure per Hour	PFH $4.1679*10^{-07}$ 1/h	
MTBF Dangerous Failures	$6.86*10^{+06}$ h	See note *3
Proof Test Interval	4 years	Recommended. Refer to Figure 3 for other options
Diagnostic Test Interval	1 Minute	For Electronics and Firmware. For Mechanics the diagnostic test interval is determined by the Servo Auto test setting. This can be configured to run between 1 minute and 28 Days. Default value is 1 hour.

Entity / parameter	Value Overfill	Remarks
Fault Reaction Time	1 minute	

*1) If other proof test interval shall be used, the diagram (Figure 3) shows how the PFD_{avg} is related to Ti.
*2) The SFF takes into account the failure detection provided by all relevant mechanical, electronics and software components of the device.
*3) MTBF is the predicted elapsed time between failures of a system in operation in accordance to the MIL HDBK 217 standard. This standard takes into account the failures of relevant electronics.

Table 5 Safety-Related Data Underfill

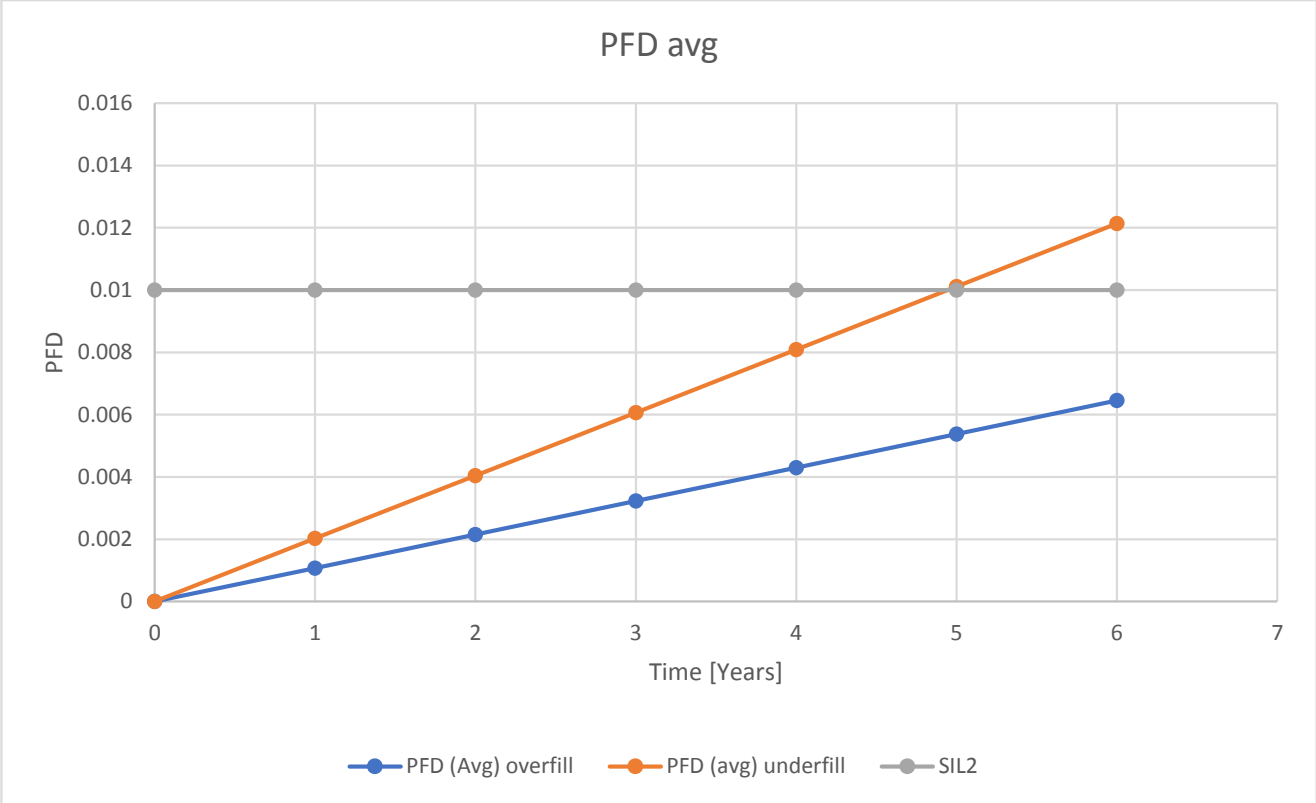


Figure 3 PFD_{avg} over Time

2.5 Design and Technical Input

2.5.1 Safety Design

The SIL compliant sensor design is located on the CAN-SERVO board. The CAN-SERVO board controls the displacer by a stepper motor and reads the frequency from the force transducer that is a measure for the weight of the displacer. Further on it implements several diagnostic measures.

The SIL compliant logic solver design comprises of the 2 SIL contacts and 4-20 mA analog output, located on the CAN-SIL board. Further on it implements several diagnostic measures.

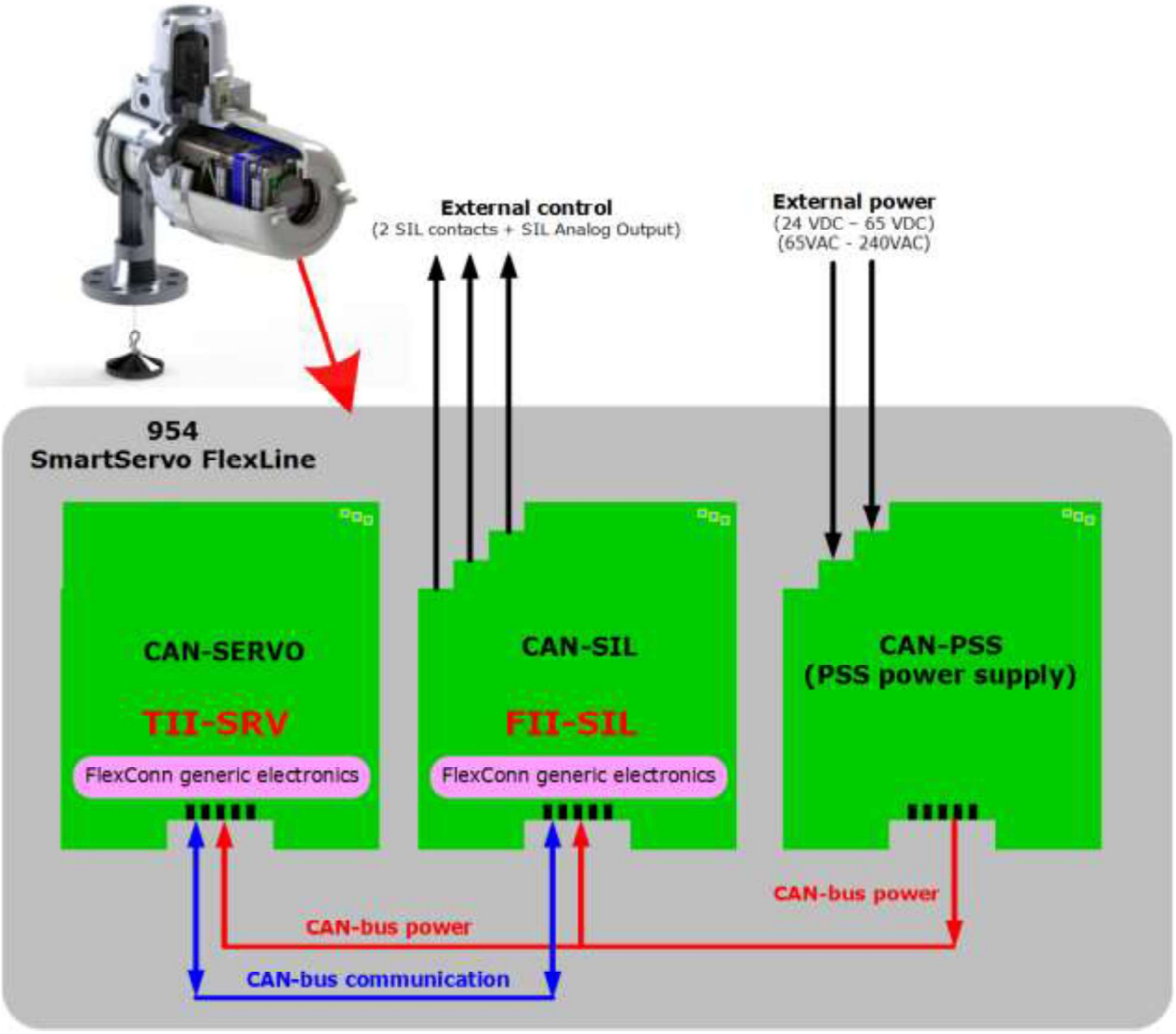


Figure 4 954 SmartServo FlexLine SIL Relevant Boards

2.5.2 Suitable Applications

Parameter		Range
Allowable differential Pressure		Max. 40 bar (4 MPa, 580 psi) (model dependent)
Temperature:	Process Ambient	-200 °C to + 200 °C (-328 °F to +392 °F) -40 °C to + 65 °C (-40 °F to +149 °F)
Process:	Density Viscosity	min. 400 kg/m3 (25 lb/ft3) max. 1 Pa s (1000 cP)

Table 6 Suitable Applications for the 954 SmartServo FlexLine

2.6 Servo Auto Test

To establish SIL compliant safety functions a sophisticated **diagnostic test** has been developed to prove that the gauge is able to measure an upward and/or downward movement of the product, reliably and covering the diagnostics.

This test is called the Servo Auto Test, and can be executed automatically at a user defined interval. It can also be prompted by a dedicated command for Proof Test purposes. Provided the required configuration is established, the user can set this test to application needs.

The Servo Auto Test is executed to prove that the moving parts of the gauge can move as intended by either moving up or moving down the displacer over a limited distance.

It has the following features:

- it is executed automatically and autonomously
- it is executed immediately after tank loading and after tank unloading, as these are critical moments
- it is executed at regular intervals
- in case of a detected failure
    - the appropriate alarm is initiated
    - the applicable hardware SIL contacts switch from closed to open state
    - the analog output gets a burn out value
- during execution, the display shows the asterisk sign (*) in the level status, all other effects of the test are hidden
    - i.e. level and SIL contacts

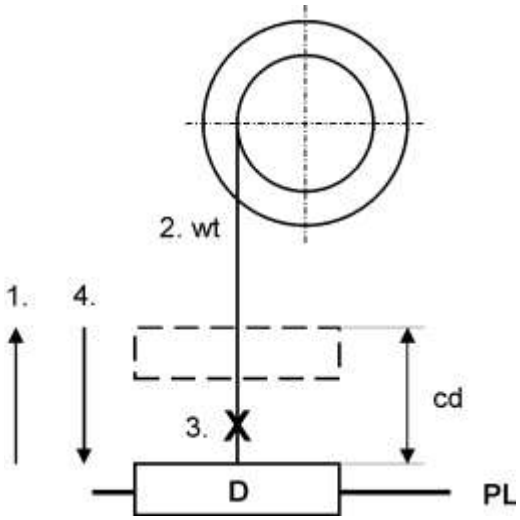
- for installed equipment (e.g. CIU's) and systems

- In SIL applications the Servo Auto Test can be enabled for overfill protection only or for the combination of overfill and underfill protection.
  In non-SIL applications the Servo Auto Test could be active as well although it can be disabled.

2.6.1 Principle of Operation

Starting from the situation that the displacer (D) is in rest at the product level (PL), the Servo Auto Test consists of these basic steps:

1. The displacer is moved over a configurable distance (cd) either up or down
2. The wire tension (wt) is measured while the displacer is being moved
3. Appropriate actions are initiated, only in case the wire tension exceeds the predetermined limit (X) caused by a mechanical obstruction.
4. The displacer is moved back to the product level



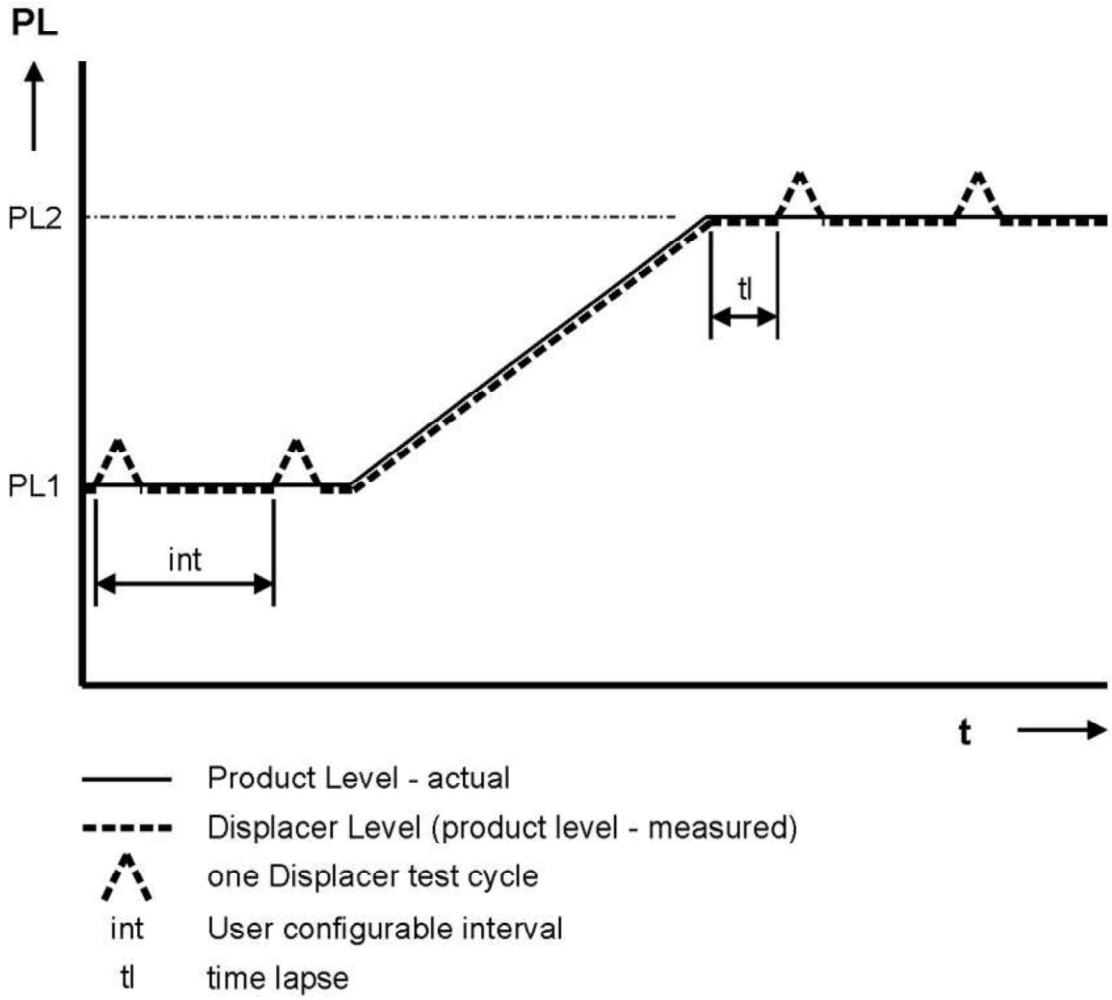
NOTE:
The duration of a Servo Auto Test mainly depends on the configuration entities.
A typical Servo Auto Test running at default settings may take approximately 15 seconds.

2.6.2 Servo Auto Test Upwards

Figure 5 shows a graph that represents the actual and measured product levels. The latter in fact is the level of the displacer.

The displacer level correctly follows the actual product level, while at set intervals a Servo Auto Test occurs. This indicates that the level gauge is in a healthy state and the moving parts of the gauge can move as intended.

The Servo Auto Test occurrences take place at a set interval when the product level is stable, or assumed to be stable. This is the case at product levels PL1 and PL2. During tank filling the Servo Auto Test is temporarily disabled. After end of filling is detected a certain time lapse (tl) passes before the Servo Auto Test is started again. Afterwards Servo Auto Test occurrences take place at the set interval again.



The product level (PL) is shown as a function of time where PL1 is the initial stable level and PL2 is the stable level after the tank was filled.

Figure 5 Servo Auto Test Occurrences

2.6.3 Servo Auto Test Upwards and Downwards

The Servo Auto Test downwards is always combined with a Servo Auto Test upwards. The Servo Auto Test upwards and downwards are executed alternately.

The Servo Auto Test occurrences take place at a set interval when the product level is stable, or assumed to be stable. This is the case at product levels PL1 and PL2. During tank filling and unloading the Servo Auto Test is temporarily disabled. After end of filling/unloading is detected a certain time lapse (tl) passes before the Servo Auto Test is started again. Afterwards Servo Auto Test occurrences take place at the set interval again.

Figures 6 and 7 show schematically how and when the Servo Auto Test up- and downwards is executed.

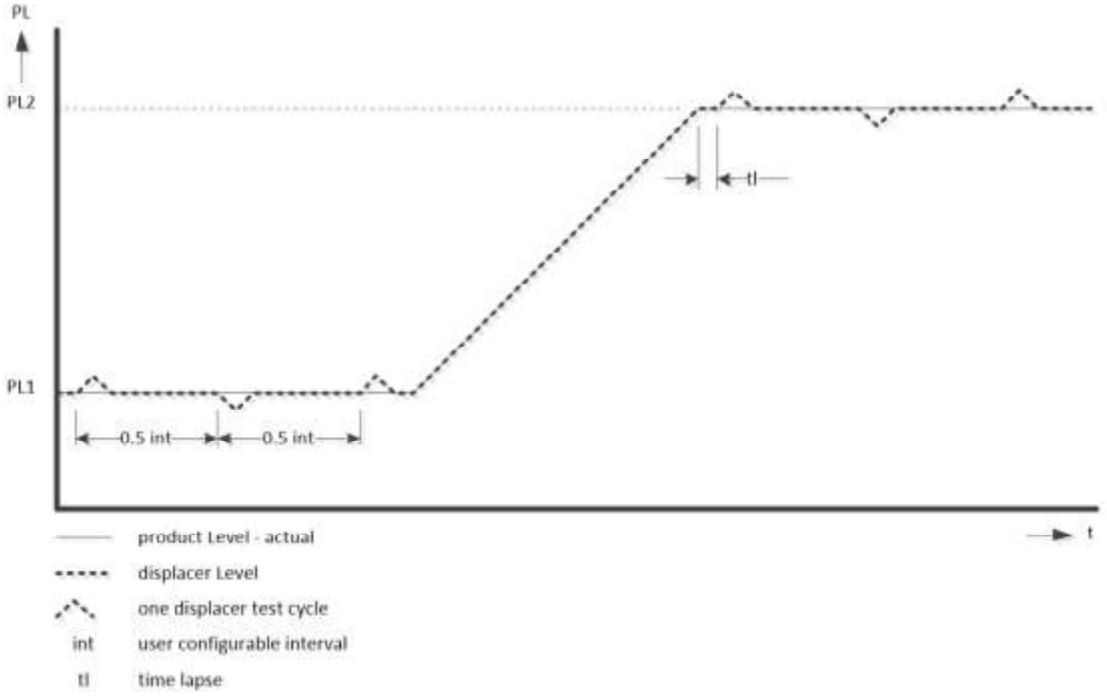


Figure 6 Servo Auto Test Upwards and Downwards, Tank Loading

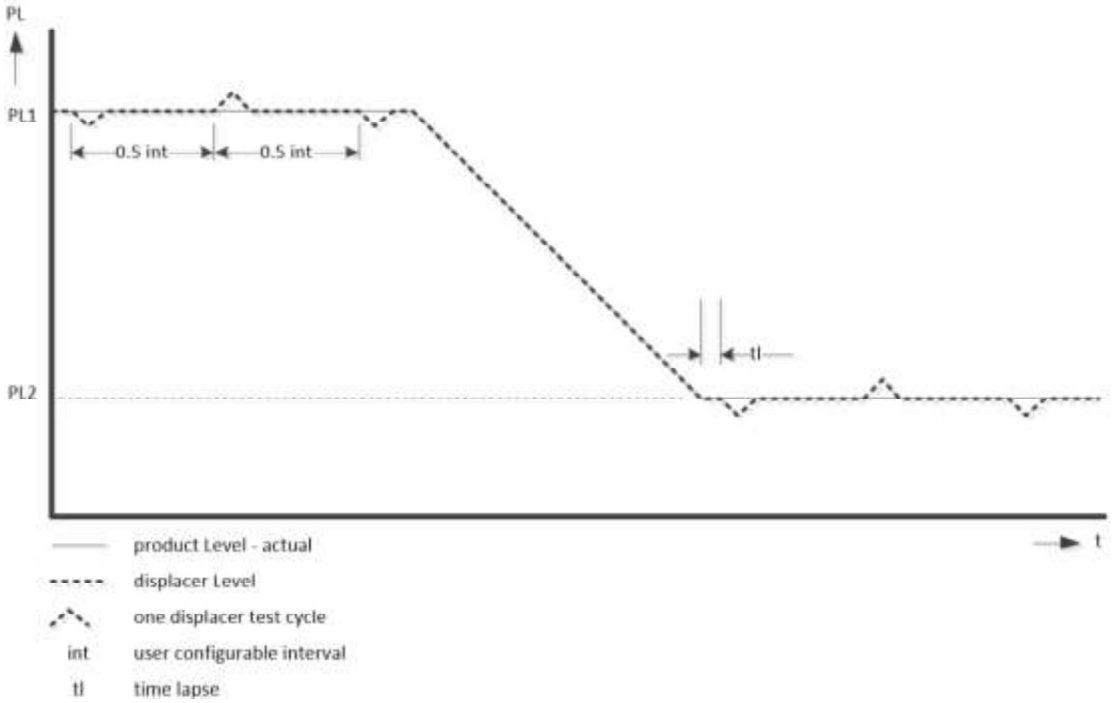


Figure 7 Servo Auto Test Upwards and Downwards, Tank Unloading

2.6.4 *Fault Detection and Reaction*

During a Servo Auto Test fault detection is conducted as follows:

1. If the displacer:

   a. Is moved upwards: in case the displacer apparent weight exceeds its predetermined high limit while the displacer is raised, the displacer cycle is interrupted; the displacer will be lowered to the product level
   b. Is moved downwards: in case the displacer apparent weight gets below its predetermined low limit while the displacer is lowered, the displacer cycle is interrupted; the displacer will be raised to the product level

2. a second displacer cycle is started; in case this cycle is also interrupted the displacer will be returned to the product level again

3. a third displacer cycle is started; in case this cycle is also interrupted the displacer will be returned to the product level

4. a failure state has now occurred

Upon a fault detection, the level gauge will initiate fault reaction as follows:

- the applicable hardware SIL contacts switch from closed to open state
- the analog output gets a burn out value
- in the GPU communication protocol the product level in the records (B, D, ZLQ) is set to “fail”
- the level data is set to fail (999---9) and its status code to “SAT failure”
- the displacer is returned to the product level
- new gauge servo commands are not executed, unless the gauge is in maintenance mode

NOTE:
Be aware that the cause of a failure must be removed before you reset the gauge. Otherwise the gauge will come into a fail state again.

The fail state of the level gauge due to a Servo Auto Test failure ends when one or more of these actions occur:

- the user initiates a reset directly via the reset command
- a power down / power up sequence

Two typical fault situations exist in which faults are detected as described above. Figures 8 and 9 both show a graph that also represents the actual product level and the displacer level. Each figure shows a typical situation. They represent identical failure states - under different conditions - as a result of a mechanical obstruction.

Figure 8 shows fault situation 1 (FS1). The product level is raising due to tank filling. Before it actually stops, end of filling is detected as a result of an obstruction. After a certain time lapse (for details see 3.4.2) a Servo Auto Test is initiated and the wire tension exceeds the limit in three subsequent attempts. One of the results of the fault reaction is that filling is stopped. In this situation PL2 represents the intended product level after filling.

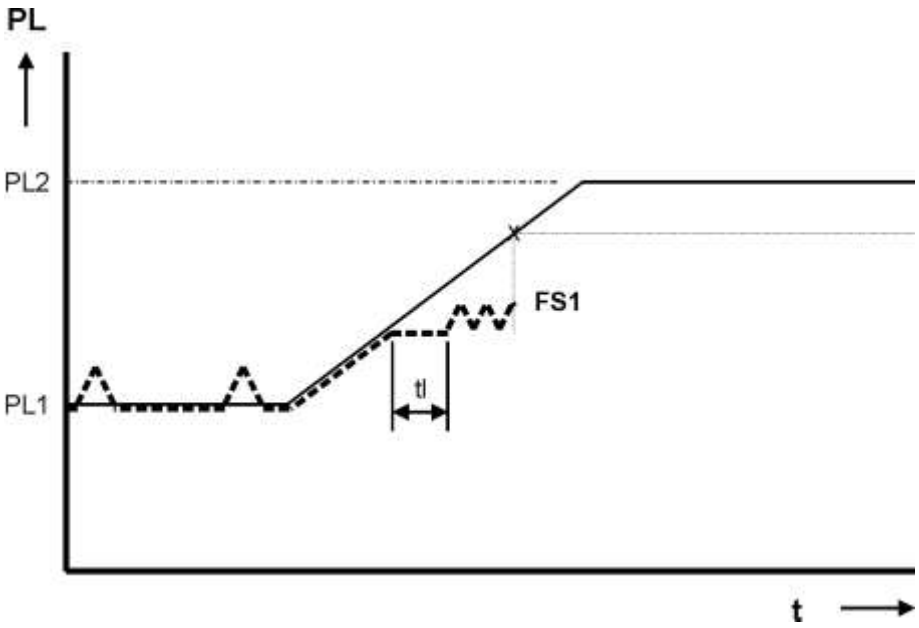


Figure 8 Failure State Example - During Tank Filling

FIGURE 9 shows fault situation 2 (FS2). The product level is stable, in this case at PL2. The Servo Auto Test is initiated at set intervals. During a Servo Auto Test the wire tension exceeds the limit in three subsequent attempts.

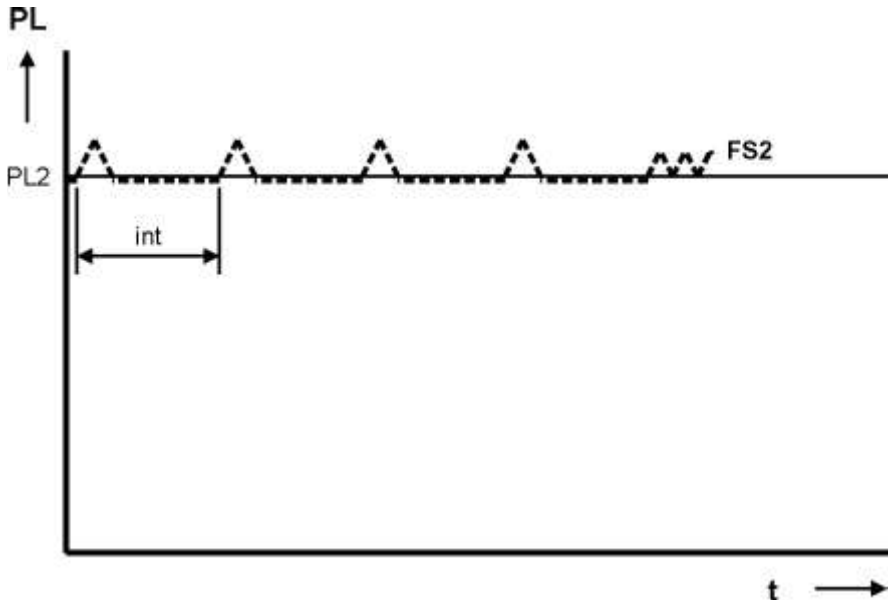


Figure 9 Failure State Example - Product Level is Stable

2.7 Logic Solver

FII-SIL (CAN-SIL) FlexConn board provides two relay contacts for signalling a safety shutdown or safe state, and one 4-20 mA analog output both for monitoring the product level and signalling a safe state. The presence of two relay contacts provides configuration flexibility, such as separate signalling of overfill and underfill conditions, or the capability of an overfill early warning to allow corrective action before an overfill condition prompts a safety shutdown.

The physical contacts of each relay are closed or energized during normal operation. When a relay is in a safe state, the physical contacts are open or de-energized. This allows loss of power to also signal a safe state.

In compliance with NAMUR NE 43, the analog output indicates a safe state when the current is at or above 21 mA, or is at or below 3.6 mA.

The following safety categories are monitored continuously to determine whether a safe state should be activated, in the order listed, at a rate of at least once per second.

Monitor Safety Categories
Contact and analog output physical health
Physical module health
Contact and analog output functional health
Product level health
Product level overfill or underfill

Table 7 Safety Categories

Overfill AND Underfill Protection Digital Output (Contacts)

Function: Open overfill or underfill protection contact in case of exceeding the overfill or underfill threshold or in case of redundancy inconsistency or in case of diagnostic measures indicating potential problems including a failing servo auto test (SAT).

Overfill AND Underfill Protection Analog Output (4-20 mA)

Function: Providing the measured product level to the 4-20 mA output. The specific safety function of the CAN-SIL board is to indicate the un-safe situation with a burn out value to the 4-20 mA output in case of a detected overfill or underfill or in case of diagnostic measures indicating potential problems including a failing servo auto test (SAT). The underfill, overfill thresholds and burnout values are configurable parameters. Typical burnout values are 3.6 mA and 21 mA.

2.7.1 Safety Shut Down Conditions

The Safety Function Status Codes define possible reasons for activation of the safe state for each output. Each is a condition monitored as part of the safety categories outlined in Section 1.1, above.

When the condition causing activation is no longer present, the output may be configured to remain in the safe state (latch) until power is cycled. This latching behaviour can be enabled or disabled for each of the possible reasons for activation.

The safe state of the analog output can be configured to be a high or low burnout current level. High or low burnout action can also be assigned for each of the possible reasons for activation of a safe state.

The safety function status codes, user actions, and the default latching behaviour and burnout action for each are defined below:

Safety Function Status Code	User Action	Latching Default	Burnout Default
PRODUCT LEVEL DATA CORRUPTED The product level value received from the tank gauge is corrupted.	Service the CAN-SERVO board	Disabled	High
PRODUCT LEVEL DATA TOO OLD The product level value received from the tank gauge is more than 5 seconds old.	Service the CAN-SERVO board	Disabled	High
PRODUCT LEVEL DATA FROM WRONG SOURCE The product level value was received from a source that is not a 954 SmartServo tank gauge.	Remove the incompatible board	Disabled	High
PRODUCT LEVEL NOT GOOD The product level value received from the tank gauge has a bad status.	Service the CAN-SERVO board	Disabled	High
PRODUCT LEVEL SCAN TIMEOUT No product level value has been received for more than 5 seconds.	Service the CAN-SERVO board	Disabled	High
DISPLACER NOT ON PRODUCT LEVEL The Servo tank gauge displacer is not positioned on the product level.	Deploy displacer to measure product level	Disabled	High
PRODUCT LEVEL OVERFILL The product level value is above the threshold value.	Correct the product level	Disabled	High
PRODUCT LEVEL UNDERFILL The product level value is below the threshold value.	Correct the product level	Disabled	High
FIXED FREQUENCY ABOVE SETPOINT The Servo tank gauge displacer is at the high motor limit.	Calibrate the servo level measurement	Disabled	High
FIXED FREQUENCY BELOW SETPOINT The Servo tank gauge displacer is at the low motor limit.	Calibrate the servo level measurement	Disabled	High
BOARD TEMPERATURE FAILURE The temperature of the FII-SIL module is excessive.	Replace the CAN-SIL board	Disabled	High
DATA MEMORY FAILURE A failure of the FII-SIL data memory has occurred.	Replace the CAN-SIL board	Enabled	High

Safety Function Status Code	User Action	Latching Default	Burnout Default
CODE CHECKSUM FAILURE The FII-SIL module code memory has become corrupted.	Replace the CAN-SIL board	Enabled	High
OUTPUT READBACK FAILURE The contact state or analog output level cannot be verified.	Replace the CAN-SIL board	Enabled	High
BOARD FAILURE A failure of the FII-SIL module electronics has occurred.	Replace the CAN-SIL board	Always enabled	0 mA
FUNCTION FAILURE A failure of the FII-SIL module electronics specific to SIL output function has occurred.	Replace the CAN-SIL board	Always enabled	0 mA
SAFETY FUNCTION NOT USED This Safety Function selection is available on all three outputs. When selected, the output is not functional. For the analog output, the output current becomes fixed at 21 mA.	Change the entity	Always disabled	21 mA
ANALOG OUTPUT MODE DISABLED The analog output is not functional, and the output current is fixed at 0 mA.	Change the entity	Always disabled	0 mA

To configure the latching functions for all three SIL outputs:

All Outputs: SIL contact 1, 2, SIL analog output			
Safe state Latching Behavior	Enabled Disabled	Defined in "Safety Function Status Codes".	Behavior of a safe state when the reason for activation no longer applies, to either deactivate when Disabled, or to remain active (latch) until power is cycled when Enabled.

Table 8 Safety Function Status Code

2.7.2 Commissioning

The FII-SIL module does not require the configuration of any entities for commissioning. By default, the board and all three output functions are already in the commissioned state. However, all outputs are in safe state, so configuration is necessary for the FII-SIL module to be used.

3. CHAPTER 3: Implementation

3.1 General

This chapter provides the information that is relevant for correct implementation of the safety-related function(s) of the 954 SmartServo FlexLine level gauge.

3.2 Assumptions and Constraints

The user must install, implement and use the 954 SmartServo FlexLine level gauge according to the conditions that are specified in this manual. The SIL compliant “overfill protection” and/or “underfill protection” will operate as intended when:

- the standard architecture is present,
- the correct configuration is installed and commissioned,
- a service tool may not be used as the primary operator interface during normal operation.

Any servo-based level gauge of the type 954 SmartServo FlexLine level gauge that does not comply with these features cannot be used for this purpose.

3.3 New Installation or Upgrade

3.3.1 New Installation

In case you have purchased a 954 SmartServo FlexLine level gauge that is suitable for SIL compliant “overfill protection” and/or “underfill protection”, this function is included by design. This means that the required architecture, hardware and software are present in the device by ordering the desired SIL outputs. Correct implementation of the function is obtained by setting the required configuration during commissioning.

3.3.2 Upgrade

In case you own a 954 SmartServo FlexLine level gauge, the SIL compliant output(s) for “overfill protection” and/or “underfill protection” can be included by upgrading the device. By ordering one of the options for SIL compliant outputs for “overfill protection” and/or “underfill protection” you will receive the required features. Implementation of the upgrade needs to be done by a qualified Service Engineer.

Implementation of the upgrade implies:

- CAN-SIL board with latest FII-SIL firmware installed.
- “commissioning” is done according to the instructions in the 954 SmartServo FlexLine Service Manual.

3.4 Configuration

Hardware and software features contribute to the SIL compliant “overfill protection” and/or “underfill protection”. Table 9 specifies the relevant boards the 954 SmartServo FlexLine level gauge must consist of the relevant firmware. Further details are described in the next paragraphs.

3.4.1 Hardware Configuration

This paragraph describes aspects of the design and integration of the applicable hardware. The required hardware configuration of the 954 SmartServo FlexLine level gauge is achieved by correct use of the specified hardware elements (see Table 9). No further requirements apply to the hardware configuration.

Board Type	Revision	Firmware	Version
CAN-PSS	REV 0	N.A.	N.A.
CAN-SERVO	REV 1	TII-SRV	≥ A1005
CAN-SIL	REV 1	FII-SIL	≥ A1001

Table 9 Required Boards and Firmware

3.4.2 Software Configuration

The following paragraphs describe the steps to achieve the correct software configuration of the 954 SmartServo FlexLine level gauge. They are:

- execution of the software settings (commissioning),
  - configuration Servo Auto Test (refer to Chapter 3.4.3)
  - configuration SIL contacts (refer to Chapter 3.4.4)
  - configuration SIL Analog output (refer to Chapter 3.4.5)
- verification of the function (refer to Chapter 3.5).

3.4.3 *Configuration – Servo Auto Test*

The configuration entities for the Servo Auto Test are present in Engauge, tab “SAT”. The default values are mostly applicable.

Extra attention is required for the entities in the Table below. See also the Service manual for more details about entities.

Entity	Default Value	Comment
Autonomous SAT enable	SAT enable up or SAT enable up down	“SAT enable up down” in case of underfill protection
SAT sample interval	60	seconds
SAT trip distance	0.0030	m
Wire tension protection	Enable	Entity present in Engauge tab “Configuration”
Wire rupture	Enable	Entity present in Engauge tab “Configuration”
Drum slip detection	Enable	Entity present in Engauge tab “Configuration”

Table 10 Basic Servo Auto Test Configuration

How to determine the value for entities “SAT sample interval” and “SAT trip distance”

These entities are related to the movement detector that samples the level in the tank at regular intervals. They are also closely related to each other. They are used to determine if the product level in a tank is stable or moving.

With entity “SAT sample interval” the user determines the time between two consecutive samples by the movement detector. Entity “SAT trip distance” represents the trip distance. If the absolute difference between two samples exceeds the trip distance it is assumed that the tank is being loaded or unloaded.

This movement detection is necessary to disable the Servo Auto Test during loading and unloading of the tank. It is also used to determine that the product movement stops and a Servo Auto Test can be initiated again.

Detection takes place after a certain time lapse. In theory, the minimum time lapse is zero (0) seconds and the maximum time lapse is 2 x “SAT sample interval”.

Although the default values for both entities are based on field data and experience, they cannot be automatically used. As circumstances of different tank systems can strongly vary, appropriate values have to be determined for any specific system.

It is advised to follow the steps below in the given order to determine the values for these entities to avoid over or underrated responses.

1. Determine the maximum deviation of the measured product level in the tank when the product level is stable ($PL_{STAB-\Delta}$), i.e. no loading or unloading. Level deviations can occur due to weather conditions, e.g. wind on a floating roof tank system
2. Set the value of entity “SAT trip distance” in the engineering units of the gauge so that it equals: PLSTAB-Δ + 1 mm
3. Determine the average product level increase per second during loading of the tank in the engineering units of the gauge. This is variable A
4. Calculate entity “SAT sample interval” as follows: SAT sample interval = SAT trip distance / (½ A)

The greater the value for entity “SAT sample interval” the longer it will take before the Servo Auto Test is executed after tank loading/unloading is finished. Preferably, this period must be as short as possible to prevent tank overfill due to a mechanical obstruction.

3.4.4 Configuration – SIL Contacts

The following configuration entities of the FII-SIL (CAN-SIL) shall be configured for SIL contact 1:

Contact 1			
Name	Value Range	Default Value	Description
Contact 1 Safety Function	< Not Used > < Overfill > < Underfill >	< Overfill >	The condition of product level relative to the threshold which will determine the activation of a contact 1 safe state, as an underfill or overfill condition. Overfill: activation occurs when the product level is above the Overfill Threshold. Underfill: activation occurs when the product level is below the Underfill Threshold. Not Used: contact 1 is activated in a constant safe state and does not perform any function.
Contact 1 Threshold	< 0 – 3.402823×10^{38} > (meters)	< 0 >	The product level limit value for determining an overfill or underfill condition for contact 1.
Contact 1 Hysteresis	< 0 – 3.402823×10^{38} > (meters)	< 0.010 >	A value relative to the threshold that will determine the point at which deactivation of a contact 1 safe state occurs after activation by an overfill or underfill condition. For an underfill, deactivation occurs when the product level is above (threshold + hysteresis). For an overfill, deactivation occurs when the product level is below (threshold – hysteresis).
Contact 1 Proof Test Interval	< 1 – 3650 > (days)	< 1825 >	The maximum time interval permitted between contact 1 proof tests. If exceed and when a contact 1 safe state is not active, the contact 1 safety function status will change to W to signal a warning that a proof test is overdue. The status code will remain as NO ERROR.
Contact 1 Proof Test Timeout	< Auto timeout off > < 5 minutes > < 10 minutes > < 20 minutes > < 30 minutes >	< 5 minutes >	If not < Auto timeout off >, the maximum time duration a contact 1 proof test will remain active. If exceeded the proof test will automatically stop.

Table 11 Contact 1 Configuration

The following configuration entities shall be configured for SIL contact 2:

Contact 2			
Name	Permitted Values	Default Value	Description
Contact 2 Safety Function	< Not Used > < Underfill > < Overfill >	< Overfill >	The condition of product level relative to the threshold which will determine the activation of a contact 2 safe state, as an underfill or overfill condition. Overfill: activation occurs when the product level is above the Overfill Threshold. Underfill: activation occurs when the product level is below the Underfill Threshold. Not Used: contact 2 is activated in a constant safe state and does not perform any function.
Contact 2 Threshold	< 0 – 3.402823 × 10^{38} > (meters)	< 0 >	The product level limit value for determining an overfill or underfill condition for contact 2.
Contact 2 Hysteresis	< 0 – 3.402823 × 10^{38} > (meters)	< 0.010 >	A value relative to the threshold that will determine the point at which deactivation of a contact 2 safe state occurs after activation by an overfill or underfill condition. For an underfill, deactivation occurs when the product level is above (threshold + hysteresis). For an overfill, deactivation occurs when the product level is below (threshold – hysteresis).
Contact 2 Stop Proof Test	Command		Terminates an active contact 2 proof test. Upon termination, the normal process will resume and contact 2 will close.
Contact 2 Proof Test Interval	< 1 – 3650 > (days)	< 1825 >	The maximum time interval permitted between contact 2 proof tests. If exceed and when a contact 2 safe state is not active, the contact 2 safety function status will change to W to signal a warning that a proof test is overdue. The status code will remain as NO ERROR.
Contact 2 Proof Test Timeout	< Auto timeout off > < 5 minutes > < 10 minutes > < 20 minutes > < 30 minutes >	< 5 minutes >	If not < Auto timeout off >, the maximum time duration a contact 2 proof test will remain active. If exceeded the proof test will automatically stop.

Table 12 Contact 2 Configuration

3.4.5 Configuration – SIL Analog Output

The following configuration entities of the FII-SIL (CAN-SIL) shall be configured for the SIL analog output:

Analog Output			
Name	Permitted Values	Default Value	Description
Analog Output Overfill Threshold	< 0 – 3.402823 × 10^{38} > (meters)	< 0 >	The product level limit value for determining an overfill condition for the analog output.
Analog Output Underfill Threshold	< 0 – 3.402823 × 10^{38} > (meters)	< 0 >	The product level limit value for determining an underfill condition for the analog output.
Analog Output Hysteresis	< 0 – 3.402823 × 10^{38} > (meters)	< 0.010 >	A value relative to the threshold that will determine the point at which deactivation of an analog output safe state occurs after activation by an overfill or underfill condition. For an underfill condition, deactivation occurs when the product level is above (threshold + hysteresis). For an overfill condition, deactivation occurs when the product level is below (threshold – hysteresis).
Analog Output Burnout Action	< High >, < Low >	< High >	The burnout action or safe state of the analog output for each of the possible reasons for activating a safe state.
Analog Output High Burnout Value	< 21 – 25 > (mA)	< 21	The safe state current level of the analog output for a condition configured for high burnout.
Analog Output Low Burnout Value	< 0.5 – 3.6 > (mA)	< 3.6 >	The safe state current level of the analog output for a condition configured for low burnout.
Analog Output Upper Range Value	< 0 – 3.402823 × 10^{38} > (meters)	< 0 >	Product level value corresponding to a 20 mA or 100% current level.
Analog Output Lower Range Value	< 0 – 3.402823 × 10^{38} > (meters)	< 0 >	Product level value corresponding to a 4 mA or 0% current level.

Analog Output			
Name	Permitted Values	Default Value	Description
Analog Output Proof Test Interval	< 1 – 3650 > (days)	< 1825 >	The maximum time interval permitted between analog output proof tests. If exceed and when an analog output safe state is not active, the analog output safety function status will change to W to signal a warning that a proof test is overdue. The status code will remain as NO ERROR.
Analog Output Proof Test Timeout	< Auto timeout off > < 5 minutes > < 10 minutes > < 20 minutes > < 30 minutes >	< 5 minutes >	If not < Auto timeout off >, the maximum time duration an analog output proof test will remain active. If exceeded the proof test will automatically stop.

Table 13 Analog Output Configuration

3.4.6 Configuration Notes

NOTE:
The "Overfill Threshold" shall be configured above the High alarm (HA) and High High alarm (HH) entity configuration of the TII-SRV product level board in case of overfill protection.

NOTE:
The "Overfill threshold" shall be configured below Motorlimit switch High and tank top level.

NOTE:
The "Underfill Threshold" shall be configured below Low alarm (LA) and Low Low alarm (LL) entity configuration of the TII-SRV product level board in case of underfill protection.

NOTE:
The "Underfill threshold" shall be configured above Motorlimit switch Low.

NOTE:
The “Analog Output Lower Range Value” and “Analog Output Upper Range Value” have a default value of “0” and need to be configured properly to avoid a zero span error.

NOTE:
After initial commissioning and configuration the W&M sealing shall be applied by W&M jumper or firmware sealing in order to be sure that SIL relevant configuration parameters (entities) are not changed unintended.

NOTE:
High current as burnout value is not allowed if the analog output is powered by the loop.

NOTE:
Using High burnout currents refer to IEC 61511-1 11.6.2 that a separate external current monitor is required.

NOTE:
When defining the over- and under fill threshold please take into account a 5 mm safety margin. When external data is used for certain compensations this data cannot part of the SIL certification. Hence some margin needs to be defined.

3.5 Verification of the Safety Instrumented Function(s)

To verify the correct functioning of the “overfill protection” and/or “underfill protection” function, carry out the procedure of chapter 4.3 "Proof Testing".

4. CHAPTER 4: Maintenance Requirements

4.1 Purpose

This chapter provides the information that is relevant for correct maintenance of the safety-related function(s) of the 954 SmartServo FlexLine level gauge.

4.2 Diagnostic Entities

4.2.1 Diagnostic Entities Servo Auto Test

To determine correct functioning of the “overfill protection” and/or “underfill protection” with the Servo Auto Test a number of diagnostic entities are available.

Table below provide an overview of the applicable diagnostic entities and their corresponding value ranges (N/A means: not applicable).

Entity	Description	Default [1]	Min to Max values [1]
SAT level last fail	Level at which the Servo Auto Test last failed	+999.9999	-999.9999 to +999.9999
SAT level last executed	Level at which the Servo Auto Test was last executed	+999.9999	-999.9999 to +999.9999
SAT minimum level executed	Minimum level at which the Servo Auto Test was performed	+999.9999	-999.9999 to +999.9999
SAT maximum level executed	Maximum level at which the Servo Auto Test was performed	-999.9999	-999.9999 to +999.9999
SAT highest number of retries	Highest number of Servo Auto Test retries	0	0 to 9
SAT number of executed tests	Number of executed Servo Auto Tests	00000	00000 to 99999
SAT status	Servo Auto Test status	N/A	N/A
SAT time elapsed since last SAT	Time elapsed since last Servo Auto Test	00000	00000 to 99999

1. Values for heights and distances are given in meters.

Table 14 Diagnostic Parameters (related to Servo Auto Test)

4.2.2 Diagnostics Entities SIL Outputs

To determine correct functioning of the “overfill protection” and/or “underfill protection” SIL outputs a number of diagnostic entities of the FII-SIL (CAN-SIL) are available.

Contact 1			
Name	Value Range	Default Value	Description
Contact 1 Health (RO)	*Status* UNDEFINED GOOD UNCERTAIN BAD *Status Category* (See section TBD for definitions) GOOD, ACTUAL VALUE GOOD, MANUAL VALUE GOOD, LAST VALID VALUE GOOD, STORED VALUE GOOD, SAFETY SHUTDOWN ACTIVE UNCERTAIN, INSTRUMENT UNCERTAIN, ENVIRONMENT BAD, HARDWARE FAILURE BAD, FIRMWARE FAILURE BAD, COMMISSIONING FAILURE BAD, CALIBRATION FAILURE BAD, OPERATIONAL FAILURE BAD, NO DATA AVAILABLE BAD, UNINITIALIZED BAD, KILLED BAD, OVERRANGE BAD, UNDERRANGE *Status Code* See section x.2, Safety Function Status Codes for definitions.	BAD BAD, UNINITIALIZED FUNCTION FAILURE	Functional health of contact 1. Any status other than GOOD will result in a safe state activation for contact 1. The default status values are indicative of an un-commissioned output function.
Contact 1 Safety Function Status (RO)	Status: H, O, U, W Status Code: Defined in Section 1.2.	Status: H Status Code: NO ERROR	H: Healthy O: Overfill condition U: Underfill condition W: Warning condition, safe state is active, or proof test is overdue (status code is NO ERROR)
Contact 1 Safety Shutdown Counter (RO)	$0 - 3.402823 \times 10^{38}$ (meters)	0	The number of contact 1 safe state activations that have occurred since commissioning.
Contact 1 Safety Shutdown Reason (RO)	Safety Function Status Code	NO ERROR	The safety function status code identifies the reason for the last time a contact 1 safe state activation occurred.

Contact 1			
Name	Value Range	Default Value	Description
Contact 1 Switch Count (RO)	$0 - 3.402823 \times 10^{38}$	0	The number of contact 1 closures, or transitions from safe state to normal state, since commissioning.

Table 15 Diagnostics Contact 1

Contact 2			
Name	Permitted Values	Default Value	Description
Contact 2 Health (RO)	*Status* UNDEFINED GOOD UNCERTAIN BAD *Status Category* (See section TBD for definitions) GOOD, ACTUAL VALUE GOOD, MANUAL VALUE GOOD, LAST VALID VALUE GOOD, STORED VALUE GOOD, SAFETY SHUTDOWN ACTIVE UNCERTAIN, INSTRUMENT UNCERTAIN, ENVIRONMENT BAD, HARDWARE FAILURE BAD, FIRMWARE FAILURE BAD, COMMISSIONING FAILURE BAD, CALIBRATION FAILURE BAD, OPERATIONAL FAILURE BAD, NO DATA AVAILABLE BAD, UNINITIALIZED BAD, KILLED BAD, OVERRANGE BAD, UNDERRANGE *Status Code* See section x.2 "Safety Function Status Codes" for definitions.	BAD BAD, UNINITIALIZED FUNCTION FAILURE	Functional health of contact 2. Any status other than GOOD will result in a safe state activation for contact 2. Default status values are indicative of an un-commissioned output function.
Contact 2 Safety Function Status (RO)	Status: H, O, U, W Status Code: Defined in Section 1.2.	Status: H Status Code: NO ERROR	H: Healthy O: Overfill condition U: Underfill condition W: Warning condition, safe state is active or proof test is overdue
Contact 2 Safety Shutdown Counter (RO)	$0 - 3.402823 \times 10^{38}$ (meters)	0	The number of contact 2 safe state activations that have occurred since commissioning.

Contact 2			
Name	Permitted Values	Default Value	Description
Contact 2 Safety Shutdown Reason (RO)	Safety Function Status Code	NO ERROR	The safety function status code identifying the reason for the last time a contact 2 safe state activation occurred.
Contact 2 Switch Count (RO)	$0 - 3.402823 \times 10^{38}$	0	The total number of contact 2 closures, or transitions from safe state to normal state.

Table 16 Diagnostics Contact 2

Analog Output			
Name	Permitted Values	Default Value	Description
Analog Output Health (RO)	*Status* UNDEFINED GOOD UNCERTAIN BAD *Status Category* (See section TBD for definitions) GOOD, ACTUAL VALUE GOOD, MANUAL VALUE GOOD, LAST VALID VALUE GOOD, STORED VALUE GOOD, SAFETY SHUTDOWN ACTIVE UNCERTAIN, INSTRUMENT UNCERTAIN, ENVIRONMENT BAD, HARDWARE FAILURE BAD, FIRMWARE FAILURE BAD, COMMISSIONING FAILURE BAD, CALIBRATION FAILURE BAD, OPERATIONAL FAILURE BAD, NO DATA AVAILABLE BAD, UNINITIALIZED BAD, KILLED BAD, OVERRANGE BAD, UNDERRANGE *Status Code* See section x.2 “Safety Function Status Codes” for definitions.	BAD BAD, UNINITIALIZED FUNCTION FAILURE	Functional health of the analog output. Any status other than GOOD will result in a safe state activation for the analog output. The default status values are indicative of an un-commissioned output function.
Analog Output Safety Function Status (RO)	Status: H, O, U, W Status Code: Defined in Section 1.2.	Status: H Status Code: NO ERROR	H: Healthy O: Overfill condition U: Underfill condition W: Warning condition, safe state is active, or proof test is overdue (status is NO ERROR).
Analog Output Safety Shutdown Counter (RO)	$0 - 3.402823 \times 10^{38}$ (meters)	0	The number of safe state activations that have occurred for the analog output.
Analog Output Safety Shutdown Reason (RO)	Safety Function Status Code	NO ERROR	The safety function status code identifying the reason for the last time an analog output safe state activation occurred.

Table 17 Diagnostics Analog Output

4.3 Proof Testing

To make sure that the safety rated loops remains SIL compliant a proof test has to be performed. For proof test interval refer to Chapter 2.4 and Figure 3.

4.3.1 Proof Test Servo Auto Test

Points of attention:

- *For Proof Testing opening of the 954 SmartServo FlexLine is not required unless test results or other findings demand internal maintenance and/or repair.*
- *Proof Test procedure can be performed by Service Engineer from:*
  - *the control system, using available diagnostic tools, such as Engauge,*
  - *as an alternative at the gauge, using a HART SmartView.*
- *It is advised to compare the test results with historic data, if available. In this way trends in behaviour can be determined.*

Follow the steps below in the sequence given:

1. *Determine that the examined gauges are certified for SIL compliant "overfill protection" and/or "underfill protection".*

   *If not **OK** - contact plant management for further action.*

   *If **OK** - continue with the next step.*

2. *Determine the actual status and values of the relevant configuration entities for each gauge. Record this data for later reference.*

   Make sure that the values of the configuration entities comply with the settings as conducted during commission and/or approved changes. Pay special attention to entity [SE] 'Servo Auto Test enabled'; this should have the default value [E], enabled.

   *If not **OK** - contact plant management for further action.*

   *If **OK** - continue with the next step.*

3. *Perform functional and performance test of the gauge in following steps:*
    - *Repeatability test,*
    - *Balance test,*
    - *Check status of servo auto test related entities,*
    - *Analysis of error codes and counters,*
    - *Verification of Level measurement,*
    - *Perform a test to activate the safety alarm through lock test or level simulation.*

4. *Analyse the results of step 3. above:*
    - *look for unusual and/or exceptional behaviour,*
    - *compare the data with historical data, and look for trends,*
    - *prepare a report for plant management; discuss any highlights,*
    - *initiate preventive and/or corrective maintenance if necessary.*

5. *Reset the relevant diagnostic entities to their default values. This applies to the entities that are under the password protection (see Table 14).*

6. *Finally, execute the required certification renewal procedure.*

4.3.2 Proof Test SIL Outputs

To verify the correct functioning of the “overfill protection” and/or “underfill protection” function for the relevant output, a “Proof Test” procedure has to be carried out.

The FII-SIL module requires periodic user operations to maintain its SIL certification. One of these activities is to perform proof tests on each of the outputs to assure the safe state functionality will perform properly when necessary. A proof test activates the safe state on each of the contacts and analog output by simulating an overfill or underfill condition and exercising the detection logic. A maximum interval can be configured for each output to warn the user if the time from the last proof test has exceeded the interval time. A configurable timeout assures that proof tests will not remain active.

The following are the relevant command and diagnostic entities of the FII-SIL (CAN-SIL) for proof testing:

Contact 1			
Name	Value Range	Default Value	Description
Contact 1 Start Proof Test	Command		Initiates a contact 1 proof test if an actual contact 1 safe state is not currently active. Upon activation, contact 1 will open to simulate a safe state. An active proof test will terminate if the contact 1 proof test timeout value is exceeded.
Contact 1 Stop Proof Test	Command		Terminates an active contact 1 proof test. Upon termination, the normal process will resume and contact 1 will close.
Contact 1 Proof Test Elapsed Time (RO)	0 – 4,294,967,295 (days)	0	The elapsed time since the last contact 1 proof test or since commissioning if no contact 1 output proof test has been executed.

Table 18 Proof Test Contact 1

Contact 2			
Name	Permitted Values	Default Value	Description
Contact 2 Start Proof Test	Command		Initiates a contact 2 proof test if an actual contact 2 safe state is not currently active. Upon activation, contact 2 will open to simulate a safe state. An active proof test will terminate if the contact 2 proof test timeout value is exceeded.
Contact 2 Stop Proof Test	Command		Terminates an active contact 2 proof test. Upon termination, the normal process will resume and contact 2 will close.
Contact 2 Proof Test Elapsed Time (RO)	0 – 4,294,967,295 (days)	0	The elapsed time since the last contact 2 proof test or since commissioning if no contact 2 output proof test has been executed.

Table 19 Proof Test Contact 2

Analog Output			
Name	Permitted Values	Default Value	Description
Analog Output Overfill Threshold	$0 – 3.402823 \times 10^{38}$ (meters)	0	The product level limit value for determining an overfill condition for the analog output.
Analog Output Start Overfill Proof Test	Command		Initiates an analog output overfill proof test if an actual analog output safe state is not currently active. Upon activation, a simulated overfill condition will occur. An active proof test will terminate if the analog output proof test timeout value is exceeded.
Analog Output Start Underfill Proof Test	Command		Initiates an analog output underfill proof test if an actual analog output safe state is not currently active. Upon activation, a simulated underfill condition will occur. An active proof test will terminate if the analog output proof test timeout value is exceeded.
Analog Output Stop Proof Test	Command		Terminates an active analog output proof test. Upon termination, the normal process will resume and contact 2 will close.
Analog Output Proof Test Elapsed Time (RO)	0 – 4,294,967,295 (days)	0	The elapsed time since the last analog output proof test or since commissioning if no analog output proof test has been executed.

Table 20 Proof Test Analog Output

Appendix A

Backward Compatibility with previous Product

The 854 ATG / XTG Servo level gauge is the predecessor of the 954 SmartServo FlexLine level gauge.

The 854 ATG / XTG Servo level gauge supported SIL outputs as follows:

Board	SIL output
SPU	2 SIL output contacts
HCU	1 SIL analog output

Table 21 Backward Compatibility

From a SIL output perspective the 954 SmartServo FlexLine is fully backwards compatible with the 854 ATG / XTG Servo level gauge. So an 854 ATG / XTG Servo level gauge can be replaced by a 954 SmartServo FlexLine without changing the interfaces to for instance a safety PLC.

NOTE:
The CAN-SIL (FII-SIL) logic solver and proof test implementation differs from the 854 ATG / XTG Servo level gauge implementation.

NOTE:
The CAN-SIL (FII-SIL) configuration entities and diagnostic entities are different compared to the configuration items and diagnostic items of the 854 ATG / XTG Servo level gauge implementation.

Appendix B

Identification of Available SIL Safety Function

The availability of one of the safety function can be identified by reading the “Sales Code” entity by using the HART SmartView local commissioning tool or the safe zone PC based Engauge service tool. The safety function is located at position 12 of the sales code with the following options:

Character	Option
-	No safety function
L	1 SIL contact
M	2 SIL contacts
N	SIL Analog Output
O	SIL Analog Output + 1 SIL contact
P	SIL Analog Output + 2 SIL contacts

Table 22 SIL Safety Function Identification

The Sales Code is also available on the type plate of the 954 SmartServo FlexLine.

For service-related questions, contact:

Technical Assistance Centre
Phone:
+1 800 423 9883 or +1 215 641 3610
E-mail:
HFS-TAC-SUPPORT@honeywell.com

For More Information
To learn more about Honeywell Enraf's *solutions, contact your Honeywell Enraf account manager or visit* *www.honeywellenraf.com*.

Americas
Honeywell Enraf Americas, Inc.
2000 Northfield Ct.
Roswell, GA 30076
USA
Phone: +1 770 475 1900
Email: enraf-us@honeywell.com

Asia pacific
Honeywell Pte Ltd.
17 Changi Business Park Central 1
Singapore 486073
Phone: +65 6355 2828
Email: enraf-sg@honeywell.com

Europe, Middle East and Africa
Honeywell Enraf
Delftechpark 39
2628 XJ Delf
The Netherlands
Phone: +31 (0)15 2701 100
Email: enraf-nl@honeywell.com

4417342 Rev.02

OIML Certificate

OIML Member State
The Netherlands

Number R85/2008-B-NL1-19.04
Project number 2173252

Issuing authority Person responsible:	NMi Certin B.V. C. Oosterman
Applicant and Manufacturer	Enraf B.V. Delftechpark 39 2628 XJ Delft The Netherlands
Identification of the certified type	An **automatic level gauge** Type: 954 SmartServo FlexLine
Characteristics	See page 2 and further

This OIML Certificate is issued under scheme B

This Certificate attests the conformity of the above identified type (represented by the sample(s) identified in the OIML Type Evaluation Report) with the requirements of the following Recommendation of the International Organization of Legal Metrology (OIML):

R 85-1 & 2 (2008) "Automatic level gauges for measuring the level of liquid in stationary storage tanks"

This Certificate relates only to the metrological and technical characteristics of the type of measuring instrument covered by the relevant OIML International Recommendation identified above.
This Certificate does not bestow any form of legal international approval.

Important note: Apart from the mention of the Certificate's reference number and the name of the OIML Member State in which the Certificate was issued, partial quotation of the Certificate and of the associated OIML Type Evaluation Report(s) is not permitted, although either may be reproduced in full.

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14 February 2019

C. Oosterman
Head Certification Board

NMi Certin B.V.
Thijsseweg 11
2629 JA Delft
The Netherlands
T +31 88 636 2332
certin@nmi.nl
www.nmi.nl

OIML Certificate

OIML Member State
The Netherlands

Number R85/2008-B-NL1-19.04
Project number 2173252

The conformity was established by the results of tests and examinations provided in the associated report(s):

- No. NMi-2173252-01 dated 14 February 2019 that includes 33 pages.
- No. NMi-2173252-02 dated 14 February 2019 that includes 17 pages;
- No. NMi-2173252-03 dated 08 January 2019 that includes 6 pages.

Characteristics of the measuring instrument
In Table 1 the general characteristics of the measuring instrument are presented.
The construction of the measuring instrument is recorded in the Documentation folder no. T8954-1.

Table 1 General characteristics

Measuring range	40 meter
Ambient temperature range	-40 – +70 °C; condensing humidity
Power supply voltage	65 – 240 Vac (-15% / +10%) @ 50/60Hz 24 – 65 Vdc
Software identification	See table 2

The complete family of measuring instruments (which are of similar construction) have the following characteristics indicated in table 2.

Table 2 Software identification

Firmware	Software version	Checksum (decimal)
TII-SRV	A1005	41572
TII-LCD	A1000	16316
HCI-BPM	A2000	3260
HCI-TRL	A2000	34966
FCI-HRT	A1008	54556